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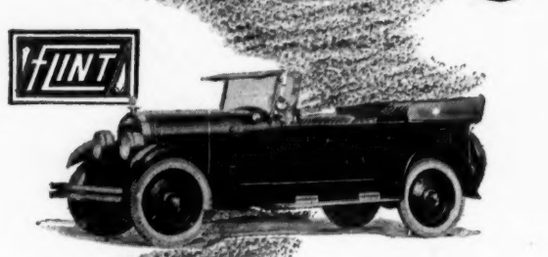


Mason Truck

AUTOMOTIVE INDUSTRIES
The AUTOMOBILE

VOL. 51 NEW YORK—THURSDAY, JULY 3, 1924 NO. 1

The Engineering Issue

ENGINEERING thought has been unusually active in recent months. Sales have not been up to expectations, but technical developments have been more numerous and more significant than in several years past. This is illustrated in the many new car models, distinctly different from those of last year, which are coming out and is emphasized by the great number of new devices which were brought to Spring Lake last week for demonstration at the summer meeting of the Society of Automotive Engineers.

This issue of Automotive Industries devoted to the practical work of summarizing the major ideas in current engineering trends and to providing specific and detailed information which should prove useful to technical men in their daily work.

The issue is divided into two sections.

The first 45 pages contain special engineering articles dealing with such timely topics as transmissions, balloon tires, lighter chassis construction and finishing materials. The data given in these articles are the result of months of close research and investigation and have been prepared specially for this issue.

The second part of the issue, beginning on page 46, contains a full report of the summer meeting of the Society of Automotive Engineers held in Spring Lake, N. J., June 24-26. The sessions on oil dilution and riding comfort brought out some particularly interesting discussion, while the air cleaner session resulted in some sharp differences of opinion.

Modern Transmission Design

By P. M. Heldt

LIKE every engineering product, the sliding pinion change gear is a compromise. It has good points and bad ones. It excels other forms of transmission in some respects but does not measure up to them in others. Up to the present, however, it has been considered to hold the balance of advantages. One thing in its favor is that it is the result of nearly thirty years of continuous development, and both its design and the methods employed in its production have reached a very advanced stage.

If one looks back over a number of years, the most notable change in gearboxes has been their contraction in size. In the high-powered cars of fifteen years ago the "transmission" was a rather bulky component which was generally mounted separately on a subframe, or even on the main frame. To-day, as used on small and moderate-sized cars, it has shrunk to such proportions that its length can be encompassed by the span of the fingers.

The change noted has come about largely as a result of the increase in engine speed. With a given pitch line pressure on the gear the power transmitted increases directly with the speed of rotation and a given horsepower therefore can be transmitted by a gear of smaller size. It is true that as the pitch line velocity increases the stress on the gear teeth with a given mean pitch line, pressure also increases, but reducing the size of the gear tends to keep the pitch line velocity down in spite of an increase in rotative speed. On the other hand, the increase in tooth stress with pitch line velocity depends upon the accuracy of form of the teeth, and great efforts have been made in recent years to turn out gears of more accurate form—not so much to enable them to carry greater loads as to make them run more quietly. Gear materials and their heat treatments also have been improved, and this has been another factor in the reduction of gearbox dimensions.

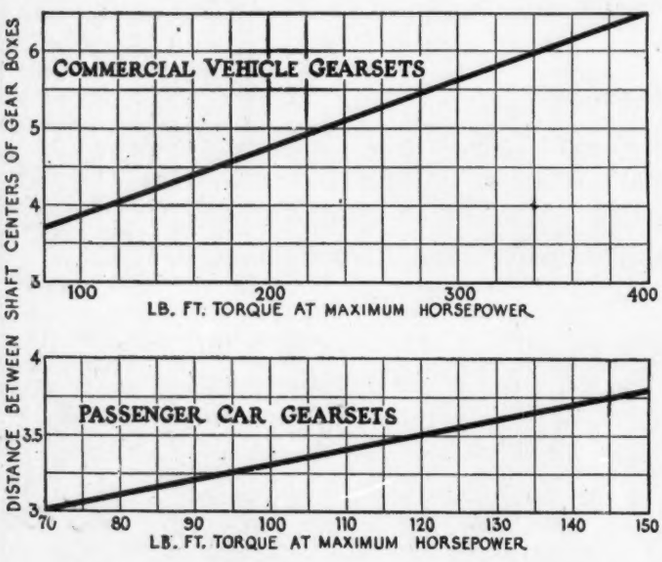


Fig. 1—Average value of center distance between gear shafts for gearsets of different torque capacities

A basic dimension of great importance in the gearbox is the distance between shaft center lines, as this practically determines two of the dimensions of the gearbox, the width and the depth. The average value of this shaft distance for gearboxes of different torque capacity is shown in the accompanying graphs, Fig. 1. The torque here referred to is the engine torque at the speed of maximum output. It is customary to rate transmissions in terms of the absolute maximum of the engine torque, which is about 20 per cent greater than the torque at the speed of maximum output.

Gear Materials

Two general classes of steels are used for the gears of sliding pinion change gears, low carbon alloy, case-hardening steel and medium carbon alloy, oil-hardening steel. The case-hardening steel seems to have been gaining gradually in popularity, first because it is much easier to work than the harder medium carbon steel and, secondly, because, when case-hardened, it presents a harder wearing surface than does oil-hardened steel. The latter, however, has the advantage of materially greater tensile strength and elastic limit, and of thus giving a better guarantee against damage by breakage.

Recently there seems to have been a slight reversion in practice in favor of oil-hardened steel, because this steel distorts less in hardening than does case-hardened steel. Of course, any distortion in hardening can be rectified by grinding, and the grinding process is gradually being introduced in the manufacture of transmission gears, but considering the total volume of production, ground gears are as yet only a small factor in the industry.

Grinding is a rather expensive process, and most of the manufacturers who have adopted it so far are in the class producing limited numbers of high class cars. Generally the grinding is limited to the gears having the highest relative pitch line velocities, as these naturally are most likely to cause noise due to distortion during heat treatment. There has been some concern regarding the possibility of cutting through the case in case-hardened gears, but there seems to be little danger of this if the ordinary precautions are taken to prevent excessive distortion and to thus limit the amount of material which needs to be removed by grinding.

Among the car manufacturers who have recently begun grinding transmission gears are Locomobile, Packard, Dorris and Lafayette.

In calculating the stresses in the teeth of transmission gears it is evidently correct to figure on the whole width of the teeth, whether the latter are chamfered or not, for

Sliding pinion change gear has many good points but involves some disadvantages. Study of theory and practice reveals possibilities of other types.

the chamfering removes no appreciable proportion of the cross section at which a break would occur.

The stress calculations, moreover, should be based on the full load torque of the engine, not its maximum torque, because with increasing engine speed the actual stresses in the gear teeth per unit of torque increase at least as fast as the engine torque decreases. In other words, if the gear is strong enough to sustain the engine torque at the speed of maximum output, it will be easily strong enough to sustain the greater maximum torque which occurs at a considerably lower speed.

Permissible Working Stresses

The permissible working stress also varies with the material, and is greater for medium carbon, oil-hardened alloy steel than for case-hardened, low carbon alloy steel. The writer does not know of plain carbon case hardening steel being used for passenger car transmissions at the present time, though it is still being used for truck transmissions, in connection with which there is less incentive to cut down the bulk and weight. The most popular steel for case-hardening transmission gears seems to be the No. 2320, a low carbon 3½ per cent nickel steel, though the No. 3120, a low carbon chrome nickel steel, is also used. Three different grades of oil hardening steel are in use, as follows: No. 2345, a 3½ per cent nickel steel with an average carbon content of 0.45 per cent; the No. 3250, a chrome nickel steel with an average carbon content of 0.50 per cent and the No. 5150, a chromium steel with an average carbon content of 0.50 per cent.

The highest tooth stress occurs in the low speed pinion on the countershaft when the engine operates at full power. Theoretically, the working stress in the reverse pinion may be even higher, but a condition where the engine operates at full load through the reverse gear is hardly conceivable, and if this pinion is given the same width of face as the low speed, it will be adequate for all possible stresses. The working stresses are lowest in the constant mesh set of gears, where the pitch line velocity is the highest.

Pitch Line Velocities

Analysis of a considerable number of transmissions shows that the pitch line velocities of the constant mesh gears corresponding to the engine speed of maximum output varies roughly from 1000 to 2000 ft. p.m. Owing to the fact that forces due to impact vary as the square of the speed, this range in speed involves very great differences in impact stresses. If the pitch line velocity is around the upper limit, the greatest care must be taken to produce gears of the highest accuracy as to both spacing and tooth profile.

The working stress in the teeth of the constant mesh pinion, as determined by means of the Lewis formula, vary from 22,000 to 38,000 lb. p. sq. in. under full load conditions. The higher stresses go together with low pitch line velocities and with steels of high tensile strength (oil-hardening steels), and the lower stresses with high pitch line velocities and case-hardening steels.

Stresses in Low Speed Pinions

In the teeth of the low speed pinion on the countershaft, the working stresses vary from 38,000 to 66,000 lb. p. sq. in., and what was said above regarding the upper and lower parts of this stress range applies here also. Pitch line velocities of low speed gears at the engine speed of maximum horsepower range from 600 to 1200 ft. p. m.

The working stress in the teeth of the intermediary gears is usually very much closer to that of the constant mesh pinion than to that in the low speed pinion, although its pitch line velocity is about midway between the velocities of the other two. This may be due either to a "rule of thumb" to make all of the gears in the transmission of the same or substantially the same width of face or to a realization that the intermediary gear will take the full engine power much oftener than the low gear.

Smaller Diametral Pitches

There has been a tendency to decrease the pitch of the gears in transmissions, and 7-9 pitch teeth are now used in many of the smaller, as well as in some of the larger gearsets. In the gearset of the Gray car, which is manufactured by the Detroit Gear & Machine Co. and is the smallest gearset regularly produced in the United States, an even finer pitch (8-10) is used.

In the case of the smaller gearsets the chief object in using a fine pitch is evidently to make it possible to use gears of smaller pitch diameter and thus reduce the size of the whole assembly. The minimum number of teeth is pretty definitely limited, owing to the fact that the tooth action becomes rather imperfect and the strength of the teeth is greatly reduced by undercut, if less than twelve teeth are used. Twelve is generally regarded as the absolute minimum number of teeth for a gear to be used in a drive where smooth running is essential, and a somewhat greater number is desirable. With the same number of teeth the finer pitch, of course, gives a gear of smaller diameter.

Theoretically, the fine pitch tooth is weaker than a coarse pitch one, but there is no difficulty in securing sufficient strength in gearsets for small cars.

As far as gearsets for larger cars are concerned, the chief advantage aimed at by the use of a finer pitch is more nearly silent operation. The inaccuracies in tooth profiles are undoubtedly substantially proportional to the principal dimensions of the profile. These inaccuracies cause accelerations and decelerations and consequent

shock, and it is a fair expectation that these shocks will be less with a finer pitch and an increased number of teeth in the gears.

Descriptions of recent designs of transmissions will be found on the last pages of this article.

Automatic and Continuously Variable Transmissions

WHILE almost all of the passenger car models and a great many of the trucks in production at the present time are fitted with the sliding pinion type of transmission, there are signs of a growing interest in other forms which promise advantages that are not attainable with the sliding gear. Attention is focused particularly on two possible improvements. Instead of changing in a few relatively large steps, the gear ratio should vary by infinitesimal gradations, or continuously, and instead of requiring expert manipulation the change should take place automatically whenever the relation between traction resistance and engine torque varied. If these improvements could be effected without sacrificing any of the admitted good points of the present type of gear—its simplicity, low cost of production, high efficiency, compactness, lightness, silent operation and long life—then a great step in advance would have been made, indeed.

One of the advantages of an automatic continuously variable transmission would be that an engine of smaller dimensions could be used for a car of given weight, which not only would cut down the first cost of the engine, and, therefore, of the car, but effect a continuous saving in fuel. There are, broadly, two reasons for using comparatively large engines. One is to make it possible to ascend all ordinary grades without change of gear; the other, to obtain the highest maximum vehicle speed.

If the speed change is automatic, all gear shifting is done away with, and this needs no consideration in the determination of the engine size or output. With the present type of change gear the final drive ratio is deliberately made large so that the engine has a surplus of power on level roads and the gears need not be shifted for any moderate grade. This large gear reduction, however, is very apt to decrease the maximum car speed, because, on a smooth level road, when the throttle is fully opened the engine will run at a higher speed than that corresponding to its maximum power, and it is obvious that the maximum engine power would give maximum car speed if the gear ratio were right.

Another advantage of the automatic continuously variable gear is realized in hill climbing. With the present type of transmission, most drivers in ascending a hill remain in any one of the higher gears as long as the engine runs fairly smoothly. When the engine is thus dragged down to a very low speed it develops far less than its maximum power. It is a common experience in driving that a grade of certain steepness which can barely be climbed on high gear, can be ascended at materially higher speed on the next lower gear. The reduction in the torque load on the engine will permit the latter to turn over so much faster that not only is the greater reduction ratio overcome but a material increase in car speed is obtained.

When the engine will no longer pull the load on high gear, the driving connection is broken and for a short period no driving force is exerted at all. During this period, of course, the speed of the car decreases rapidly, especially if the grade is steep.

With an automatic, continuously variable transmission, the engine could be kept running near its speed of maximum output from the foot of the hill to the top, without interruption, hence the average speed of the ascent with an engine of given power and a car of given weight should be materially increased, and the shocks on the mechanism due to the sudden interruption of the drive, and its re-establishment at a different ratio, would be eliminated.

A very simple form of automatic continuously variable gear (which may have some practical disadvantages but serves excellently to illustrate the principles involved) is shown in Fig. 2, the drawing being reproduced from a communication by L. J. Napier to *The Automobile Engineer*. The device consists of a simple friction disk and wheel; but the wheel, instead of being arranged to slide on a splined shaft, is mounted on a shaft having a coarse pitch thread, quite similar to the thread of a Bendix drive shaft. This shaft is surrounded by a coiled spring which tends to force the wheel toward the outer edge of the disk.

When power is transmitted through the device, the torque on the wheel causes it to turn on its shaft, on the coarse pitch thread, compressing the coiled spring

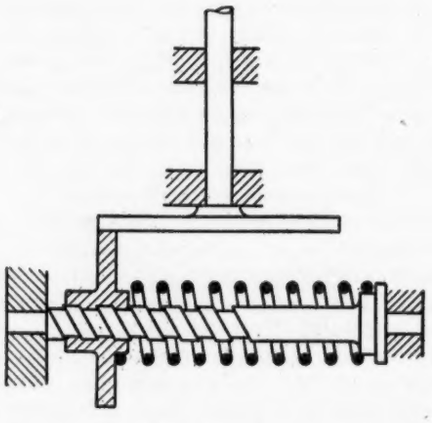


Fig. 2—Diagram of an automatically variable friction drive

until the pressure of the spring balances the axial component of the pressure between the threads of the shaft and the wheel hub, which pressure, of course, varies directly with the torque transmitted. If the resistance to rotation of the driven shaft increases, the wheel will compress the spring more, thereby approaching closer to the center of the driving disk and increasing the transmission ratio. On the other hand, if the resistance to rotation of the driven shaft decreases, the spring pressure will overcome the axial component of the pressure between the threads of the wheel hub and the shaft, and the wheel will move further from the axis of the disk, decreasing the ratio of transmission.

With a constant reduction ratio between engine crankshaft and rear axle (constant drive wheel diameter be-

ing assumed), as the traction resistance (and with it the rear axle resisting moment) increases, the speed of the engine decreases. From the fuel economy standpoint the best results are obtained when the engine is operated under full throttle, and from this point of view the transmission ratio should be so controlled that the engine is always substantially fully loaded. However, this would often result in speed too high for safety, besides which it would generally entail too great wear and tear on the engine, because our present day automobile engines are not built to run under full load continuously. The engine load, of course, can be controlled by means of the throttle.

Variable Throw Type Transmissions

In the following we will have occasion to refer repeatedly to the "variable throw" type of transmission, and it may therefore be well to describe a representative of this type, which, since it is not in use on automobiles at the present time, probably is not familiar to a good many readers. The transmission chosen for description is the Strong, which was originally developed in 1900 and which was built into a number of commercial vehicles manufactured by the Union Motor Truck Co. of Philadelphia. Two of these trucks took part in commercial vehicle contests held by the Automobile Club of America in 1903 and 1904.

This truck had a horizontal opposed engine with a disk-shaped flywheel at one end of the crankshaft. A 3-in. radial hole was bored entirely through this flywheel (see Fig. 3) to take a bronze piston fitted with a leather cup at one end and a coiled compression spring at the other. At the middle of the piston, lengthwise, there was a boss into which was fitted a crankpin which extended through a slot in the face of the flywheel disk. An oil passage extended all the way through the crankshaft and radially from the bore of the flywheel to near

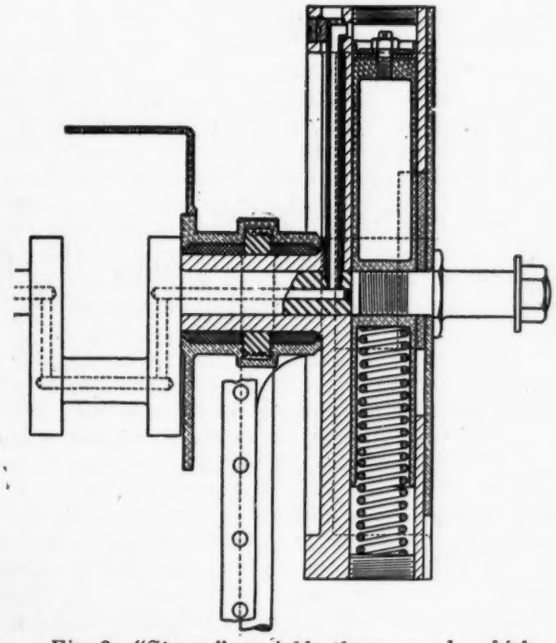


Fig. 3—"Strong" variable throw crank, which is forced by oil pressure against the pressure of a coiled spring to a greater or smaller distance from the axis of rotation

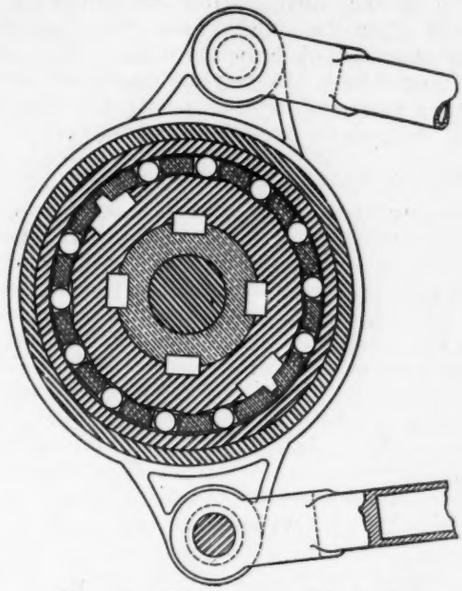


Fig. 4—Silent reversible roller ratchet used in connection with the variable throw crank shown in Fig. 3

the circumference thereof, where it communicated with the outer end of the cylinder containing the piston. Oil could be pumped through this passage into the cylinder behind the piston and the piston thus forced toward the other end against the pressure of the spring. The result of this was that the crankpin, which without oil pressure on the piston occupied a position concentric with the crankshaft, was moved into an eccentric position and given a throw of greater or smaller extent. The driver could control this throw by either pumping more oil into the cylinder in the flywheel or by letting it escape therefrom.

The Roller Ratchet

From the crankpin referred to, two tubular connecting rods extended to a "silent reversible roller ratchet" at the center of the rear axle. A drum of hardened tool steel, 7 in. in diameter by 8 in. long, was keyed to the driving sleeves of the axle. This drum had cam surfaces cut on its periphery, as may be seen from Fig. 4. It was surrounded by a slotted bronze cage containing twenty-four ⅝-in. hardened steel rollers. This cage was connected to the steel center by two keys having a straight seat in the center and a helical seat in the cage. The keys could be moved endwise by the driver, with the result that the rollers were brought closer to one or the other end of the cam surfaces.

The rollers were surrounded by two cast steel sleeves, each 4 in. in width and provided with a radial arm to which one of the two connecting rods from the crankpin was connected by a forked joint. When the engine was running and the crankpin set off center, the two steel sleeves would be given a rocking motion around the axle center. At any particular instant their motions around the axle would be in opposite directions. If the cages were moved to bring the rollers near one end of the cam surfaces, the rollers in one sleeve would wedge between it and the cam surfaces during the backward throw, say,

and those in the other during the following forward throw, and when the rollers were thus wedged, motion would be transmitted from the rods to the centers of the driving ratchets. By moving the helical keys in the steel center from one extreme position to the other the direction of the drive could be reversed.

Speed Control by Varying Crank Throw

The driving speed was controlled by increasing and decreasing the eccentricity of the crankpin on the flywheel. The oil was forced into the flywheel cylinder by means of a plunger pump driven from the engine through a small friction clutch, and when the driver wanted to increase the speed of the car he engaged this clutch and set the pump working, which increased the eccentricity of the crankpin. The oil had to pass through a check valve, so the crankpin was locked in any given position, and when it was desired to disconnect the engine it was only necessary to open this check valve, when the coiled spring behind the piston would force it back to the concentric position and thus reduce the throw to zero.

To make it possible for a passenger car to take any grade found on regularly traveled roads, the maximum available tangential force on the driving wheels must be equal to about 30 per cent of the weight of the car with load. With a normal proportion of about 1:16 between the piston displacement and the weight of the car loaded, this calls for a total reduction on low gear of about 15 to 1. It is one of the characteristics of the continuously variable transmission of the variable throw type that an almost infinite reduction ratio can be obtained, but the particular advantage of this feature in a passenger car is not very apparent. Undoubtedly a somewhat greater maximum reduction than 15 to 1 would be wanted, because, as already pointed out, a smaller engine could be used with such a gear, but a maximum reduction ratio of 20 to 1 would probably meet all requirements even with a relatively small engine.

There are three distinct methods of changing the ratio of transmission automatically. One consists in making use of the torque reaction to vary the gear ratio (as in the case of the friction drive already described); a second, in utilizing the centrifugal force of a device rotating at a speed proportional to that of the engine, and the third in converting the energy delivered at the driving shaft into kinetic energy, storing it in oscillating masses, and reconverting it into mechanical energy at the driven shaft with the rotative speed and torque changed in inverse ratios.

Speed-Torque Relation

Without a change in gear ratio the engine torque will vary directly with the rear axle torque, while with automatic change of transmission ratio by the torque reaction, if the rear axle torque increases the ratio will increase and the change in ratio can be so related to the change in rear axle torque that for an increase in the latter the engine torque will either increase, remain constant or decrease.

The most rational plan would seem to be to have the engine torque increase slightly with the rear axle torque. The reason for this is that when the rear axle torque is a maximum, that is, in very hard pulling, the engine torque should also be a maximum. In other words, as the traction resistance increases the engine should be pulled down in speed. Of course, if the engine speed were maintained practically constant the engine would develop more horsepower under heavy traction conditions and would permit of greater car speeds, but frequently heavy traction is associated with rough road surfaces, under which condition it is not desirable to run very fast. The car speed, of course, can always be cut down by means of the throttle, but this tends to lower the fuel economy.

Let us suppose that the transmission is so arranged that the gear ratio increases in the same proportion as the rear axle torque. Then the torque required of the engine would remain constant, and as long as the throttle remained in the same position the engine speed would remain constant, irrespective of road conditions.

If the throttle were opened further, the engine would generate a greater torque and this would result in an increase in engine speed and in car speed. The increase in car speed would be accompanied by a slight increase in traction resistance, chiefly due to the fact that the air resistance varies as the square of the speed, and this would result in increased axle torque and a further increase in transmission ratio, but within moderate limits of car speed the latter would increase almost in direct proportion to the engine speed. Upon closing of the throttle the reverse action would take place; that is, both the engine speed and the car speed would decrease in substantially the same proportion.

Calculation of Gear Ratios Required

In the above we have assumed merely that the transmission ratio varies directly as the rear axle torque without having fixed the relation between the transmission ratio and rear axle torque for any particular value of the latter. This relation is fixed for maximum car speed conditions by the requirement that when the throttle is opened wide on a hard, level road the engine shall attain approximately the speed at which it develops its maximum power.

This ratio probably would be somewhat less than that now used on the average passenger car. At any rate, from the weight and forwardly projected area of the car, data for a traction resistance-speed curve would have to be carefully calculated and the curve drawn. From this a driving horsepower-speed curve can be made, and, by making a suitable allowance for loss in transmission, the vehicle speed which calls for a power of propulsion equivalent to the maximum engine horsepower can be determined. Then, from the rear axle rotative speed corresponding to this car speed and the engine speed corresponding to maximum engine output, the required transmission ratio can be readily calculated.

The above statement is based on the assumption that considerable importance is attached to securing the maximum possible speed on a hard, level road from an engine of given cylinder dimensions. If fuel economy were a more important consideration, then the transmission ratio should be made somewhat smaller, so that the engine would be held down to a lower speed, for it is a well-known fact that for a given throttle position the engine operates at maximum economy somewhat below its speed of maximum output. However, under this condition, and provided the law of variation of the transmission ratio were such that the input torque increased with the output torque, the maximum power of the engine could never be utilized except on down grades.

Thus the lowest transmission ratio is set at such a

value that when the engine turns at its speed of maximum output, it requires all of this output to propel the car. Another point in the rear axle torque-transmission ratio graph can be found by assuming that when the rear axle torque is a maximum and the engine runs at its minimum speed of stable operation under full throttle, the propulsive effort at the circumference of the driving wheels is equal to 30 per cent of the car weight with load.

Application to a Specific Case

Application of the above to a practical example may clarify some of the points brought out. Suppose we have a car weighing with load 4200 lb. which is equipped with an engine of 250 cu. in. piston displacement. This engine may be expected to have a full throttle power curve like that shown in Fig. 5. Allowing 25 per cent for loss in the transmission, the net horsepower for application to the driving wheels at the engine speed of maximum output is 39, and the corresponding rear wheel torque is 86 lb.-ft. multiplied by the transmission ratio.

The forwardly projected area of the car may be taken at 16 sq. ft. Assuming the traction resistance to be 25 lb. per 1000 and the air resistance 0.003 V^2 lb. per sq. ft. of frontal area, where V is the car speed in miles per hour, the horsepower consumed by the car is

$$HP = \frac{4200 \times 25 \times V \times 88}{1000 \times 33{,}000} + \frac{16 \times 0.003 \times V^2 \times V, 88}{33{,}000}$$

$$= 0.282\,V + V^3/7820 = 39$$

$$V^3 + 2205\,V = 310{,}000$$

$$V = 57 \text{ m.p.h. (approximately)}$$

At 57 m.p.h. the rear wheels turn at

$$(57 \times 5280 \times 12)/(60 \times 32 \times 3.1416) = 598 \text{ r.p.m.}$$

and as the engine turns at 2400 r.p.m. the reduction ratio should be

$$2400/598 = 4 \text{ to } 1 \text{ substantially.}$$

It was pointed out above that the maximum rear axle torque required is such that the tangential force at the rim of the wheels is equal to about 30 per cent of the weight of the car with load. In this case, therefore, the tangential force would be

$$0.30 \times 4200 = 1260 \text{ lb.,}$$

which with 32 in. driving wheels corresponds to a rear axle torque of

$$(1260 \times 16)/12 = 1680 \text{ lb-ft.}$$

The low speed torque of the engine is 144 lb-ft., which with a loss of 25 per cent in transmission leaves

$$0.75 \times 144 = 108 \text{ lb-ft.}$$

available for transmission to the axle. The transmission ratio therefore must be

$$1680/108 = 15.55.$$

With a gear of this type the effective transmission ratio under all conditions depends entirely on the rear axle torque. The ratio in this case therefore should be 4 when the rear axle torque is $4 \times 114 \times 0.75 = 342$ lb-ft. and 15.5 when the rear axle torque is 1680 lb-ft. If the gear is designed to give the ratios mentioned for these two rear axle torques then all other driving conditions will be taken care of automatically.

One feature of the manually controlled variable throw gear, that a practically infinite reduction ratio can be obtained in emergency cases, seems to be rendered unattainable in the automatic form. Of course, as long as the engine is in good operating condition it will always furnish the necessary torque to move the car through the transmission ratios provided for. For any given road or traction resistance conditions there is a throttle opening below which it is impossible to go without stalling.

An example of the first method of varying the transmission ratio automatically has been given already. The second method, that is, causing the change in transmission ratio to be effected by means of a centrifugal governor on the engine or connected with the driving shaft, is obvious enough in theory, and the plan has been used in connection with transmissions of the planetary type in which the clutch and friction bands were controlled by centrifugal weights. In that case, of course, the variation in speed is not continuous.

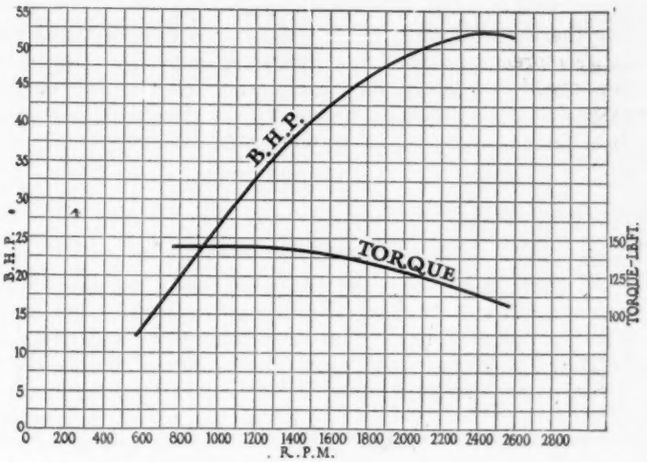


Fig. 5—Horsepower curve of 250 cu. in. engine on which transmission calculations are based

Inertia Mass Transmissions

The third method is the least common and requires some explanation. Suppose a series of oscillating weights (pendulums or oscillating flywheels) so interconnected between the driving and driven shafts that when there is any difference in speed between the two shafts these weights are alternately accelerated and decelerated, or oscillated with a given amplitude, at a rate proportional to the difference between the speeds of the two shafts.

There are four phases in the period of an oscillating weight. During the first period it is accelerated in one direction and absorbs energy which it stores as kinetic energy. In the particular case here under consideration this energy naturally would come from the driving shaft. During the second phase the weight slows down or decelerates and gives out the stored energy again, in this case to the driven shaft. Next the weight begins to move in the opposite direction, being accelerated again by the driving shaft, and finally it is again decelerated and imparts its energy again to the driven shaft.

With given weights and a given amplitude of oscillation the average power which these oscillating weights can impart to the driven shaft depends, of course, on the rate of oscillation, varying as the square of this rate. For instance, let us assume that there are two oscillating weights,

each equivalent to 50 lb.; that the amplitude of oscillation is 3 in. and that there are 600 complete oscillations per min. As the amplitude of oscillation is 3 in. the distance through which the weight moves during a complete oscillation is 6 in., and with 600 complete oscillations per min. the weights have a total motion of 3600 in. (300 ft.) per min. = 5 ft. p. s. Assuming the acceleration and deceleration both to be uniform, the maximum speed of the weights will be twice the average, viz., 10 ft. p. s. When at this speed, each weight has stored up

$$(50 \times 10 \times 10)/(2 \times 32.16) = 77.8 \text{ ft.-lb.}$$

As there are 600 complete oscillations per min. and the energy stored up when the weight is moving at its maximum speed is given out during one of the four equal phases of the oscillation, this energy is given out in 1/2400 min. Hence energy is given out at the rate of

$$2400 \times 77.8 = 186{,}500 \text{ ft.-lb. p. m.,}$$

which is equal to

$$186{,}500/33{,}000 = 5.65 \text{ hp.}$$

An example of this type of transmission, taken from a patent issued to William Howard of Boston, is shown in Fig. 6. The driving shaft at its end carries two eccentrics arranged at 90 deg. with each other, and the driven shaft carries two similar eccentrics. One rod from each pair of eccentrics connects by pivot joints to a sliding weight, and a rod from the other eccentric of each pair connects similarly to a sliding weight arranged on the opposite side of the shaft from the first. The sliding weights are constrained by guides carried by a housing to follow radial paths and are connected together by coiled springs on opposite sides.

It is readily seen that if the driven shaft were held from rotation and the driving shaft rotated, during each complete revolution of the driving shaft the oscillating weights would make one-half oscillation, moving radially away from or toward the shaft. This is made possible by the fact that the guides controlling the motion of the oscillating weights are free of both the driving and driven shafts, and will always maintain a position midway between the angular positions of the two eccentrics. For instance, if the driven shaft is held from rotation and the drive shaft is made to describe one revolution, the housing carrying the guides will make half a revolution.

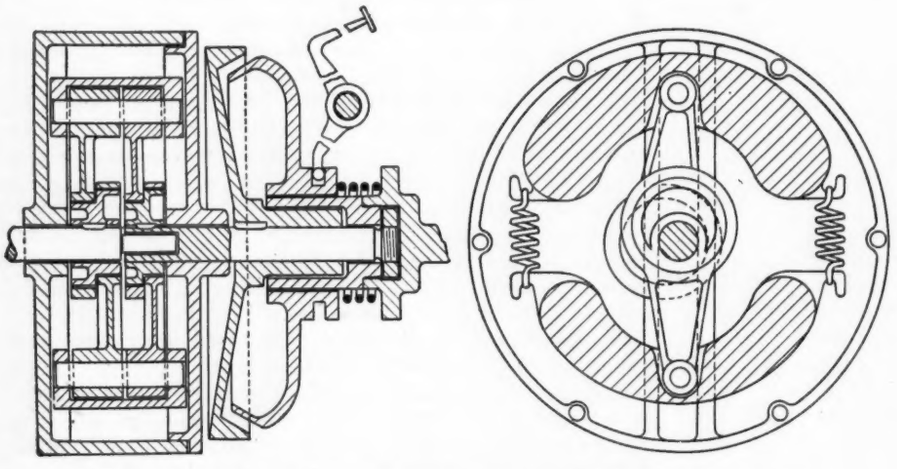


Fig. 6—Type of automatic transmission embodying inertia masses

If the driven shaft revolves, the speed of oscillation will be equal to half the difference between the speeds of the driving and driven shafts. Evidently centrifugal force would have an influence on the operation of a device of this character, tending to make it easier to accelerate the weights outwardly and more difficult to accelerate them inwardly, and the inventor has endeavored to overcome this by connecting the two weights on opposite sides of the axis of rotation by coiled springs, the tension of which is intended to counterbalance this force. However, the centrifugal force varies as the square of the speed and the springs could balance it at one speed only. The speed here referred to is the rotary speed of the inertia masses, which is equal to one-half the difference between the speeds of the driving and driven shafts.

Transmission Development Has Interesting History

APPROXIMATELY eighty patents have been issued in the United States since the beginning of the century on automatic and variable throw types of transmission, and in the following are given brief abstracts from the specifications of the more interesting types. Many of the earlier devices are mere kinematic conceptions rather than mature designs. The most interesting of all is undoubtedly the one described last, the final development of Hunt's inertia mass transmission, which is claimed to give a non-intermittent, uniform transmission of power with automatic variation of the ratio of rotary speeds in accordance with the resisting moment (torque load) on the driven shaft and without inherent vibratory forces.

A continuously variable gear invented by L. M. Dieterich of Hartford, Conn., which was described in *The Horseless Age* of Nov. 7, 1900, is shown in Fig. 7. The driving and driven shafts are arranged co-axially and both are provided with a disk at their adjacent ends. Adapted to engage with the circumference of this disk is a number of friction pawls which are carried on arms capable of swinging around the respective shafts and whose outer ends are connected by links to the rims of two wheels mounted on opposite ends of a short shaft located between the driving and driven shafts and which can be moved into a more or less eccentric position with respect to these shafts.

Considering the driving shaft with its disk, the wheel corresponding to these parts being eccentric thereto, if the driving shaft rotates, the pawl *A*, which is the one closest to the angular position in which the circumferences of the disk and wheel are farthest apart, will grip the circumference of the disk, and driving effort will be transmitted through it to the wheel. Each point in the circumference of the wheel naturally will move at the same speed around the axis *B* of the wheel, but that point (*A*) which is closest to the axis *D* of the disk will turn around the axis of the disk at the greatest angular velocity. By referring to the drawing it will be seen

that, owing to the shape of the friction pawls, the arm which gives to the wheel the fastest motion around its axis will be held in engagement with the cam, as the arms may well run ahead but cannot lag behind the disk. The reduction ratio obtained between the driving shaft and the wheel or intermediate part is substantially equal to the ratio of the sum of the whole radius and the eccentricity to the wheel radius.

The connection between the intermediary and driven parts is made in the same manner as between the driving and intermediary parts, and the points of attachment of the links to the two wheels are opposite. The links extend from the two sets of arms in opposite directions.

It is claimed that with this gear the eccentricity of the intermediary part to the driving and driven shafts will vary automatically when the resistance encountered by the driven shaft varies. Referring again to the drawing, the link which connects the arm engaged to the disk by its clutch, with the wheel, tends to move the latter into a a position of greater eccentricity. This tendency is opposed by the interaction between the driving link and its wheel on the driven side, and as long as there is uniformity of resisting moment the system is in equilibrium. If the resisting moment increases the intermediary member will be moved toward a position of less eccentricity, until a condition of equilibrium is again established. The bearing of the intermediary shaft is so supported that it can move only in a straight line intersecting the common axis of the driving and driven shafts.

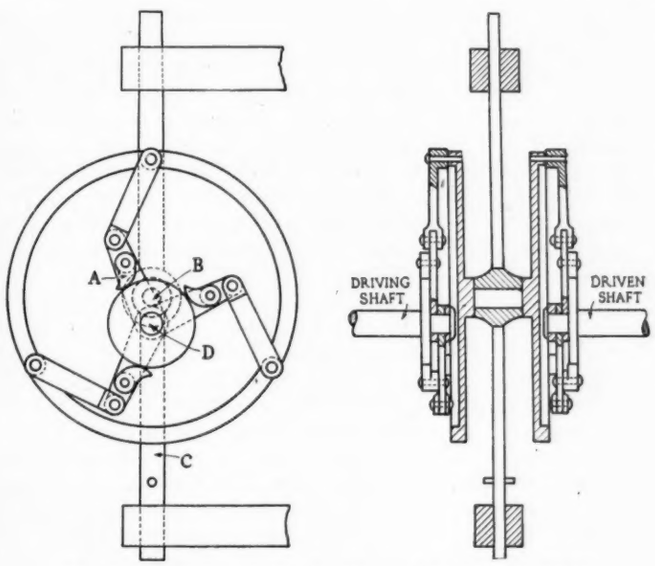


Fig. 7—Diagram of Dieterich variable transmission

Fischer and Otto in 1901 patented a combination (Fig. 8) of a vibrating link *A*, an adjustable fulcrum *B* for the link, a driving crank *C*, a driving rod *D* pivoted to the free end of the link and to the crank, a slide block *E* in the link, a driven shaft *F*, a reciprocating clutch *G* therefore and a reciprocating rod *H* pivoted at one end to the clutch lever and at the other end to the slide block. This patent was applied for in November, 1896, very early in the era of the gasoline automobile. The clutch (see detail view) consisted of a drum fastened to the driven shaft, within which drum there were two segments hinged together, with a cam between their free ends which projected laterally from the driving part. This driving part was in the form of a disk with a lug from which connection was made to the clutch lever by a link. The driving member of the clutch, while spanning the driven shaft, could rock around the axis of the cam and was so arranged as to expand the segments, causing them to grip the drum when the clutch lever turned in one direction, and allow them to contract and thus to release the drum when the lever turned in the opposite direction.

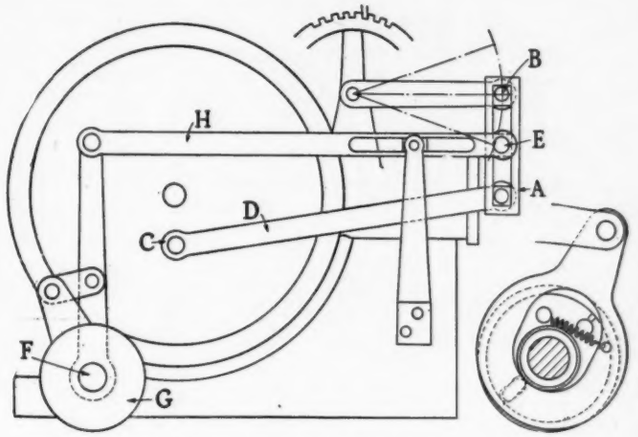


Fig. 8—Fischer & Otto variable throw transmission

W. L. Judson of Chicago in 1901 patented a variable speed drive comprising two eccentrics on the driving shaft from which eccentric rods extended to a link which at its center had a pivotal connection with a slide. This slide had lugs on opposite sides from which extended connecting rods to roller ratchets engaging with the inner surface of the drum. By means of helical keys on the driving shaft the phase relation of the two eccentrics could be changed and thus the throw of the slide varied by imperceptible gradations from zero to the maximum.

Nathan White of Pasadena, Cal., in 1902 patented a power transmitter for automobiles in which two oscillating links were used to get a variable throw, the power being transmitted to the rear axle by means of ordinary pawl and ratchet combinations. One end of each link was held stationary while the other one was reciprocated through a connecting rod from a crank pin, the two crank pins being set opposite to each other or 180 deg. apart.

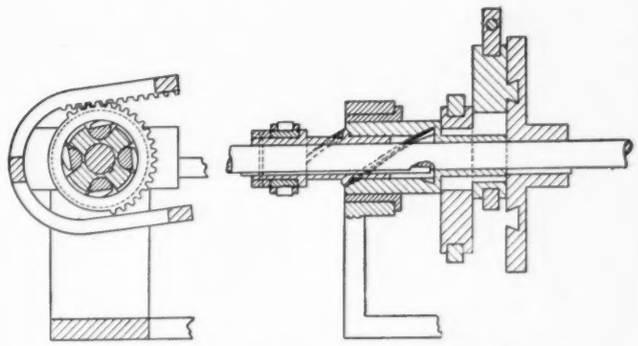


Fig. 9—Details of Judson's variable throw transmission, including angularly adjustable eccentrics to give a variable throw and roller ratchet for converting the reciprocating into rotary motion

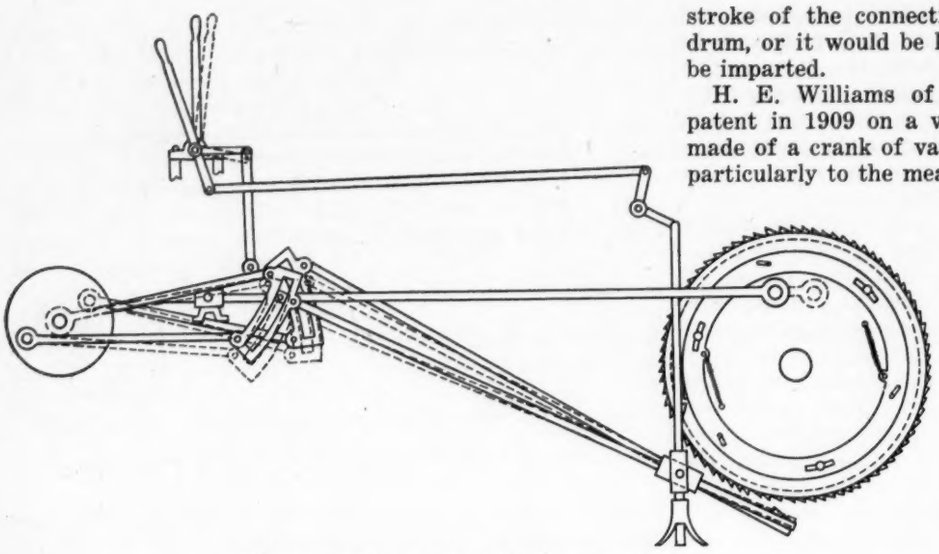


Fig. 10—White variable throw transmission

In 1907 W. and G. F. Meischke-Smith of Paris took out a patent on a driving and reversing mechanism which comprises a drum on the rear axle surrounded by a brake band which can be applied to the drum by connection from its lever to a crank on the engine. The reciprocating motion thus imparted to the end of the brake lever causes the lever first to rock around its own axis, thus tightening the brake band on the drum, and then to move the drum around its axis. To prevent a similar action during the reverse stroke, a stop is provided which limits the rocking motion of the brake lever around its own axis in such a degree that the band will not be tightened on the drum; and in order to vary the amount of motion imparted to the drum during the forward stroke, an adjustable stop is provided which limits the rocking motion of the brake lever so it will allow more or less slip of the band on the drum. This idea, of course, is very crude, for not only does it not permit of an increase in rear-axle torque with increase in rear-axle speed, but it would result in friction loss between the band and drum proportional to the decrease in speed. For instance, if the speed were reduced by slippage to one half, just as much power would be wasted in friction between band and drum as would be usefully transmitted. Finally, it would be next to impossible to so set the adjustable stop as to cause a given amount of slippage. The friction between band and drum would either exceed that necessary to cause the vehicle to move, in which case the full motion corresponding to one stroke of the connecting rod would be imparted to the drum, or it would be less, in which case no motion would be imparted.

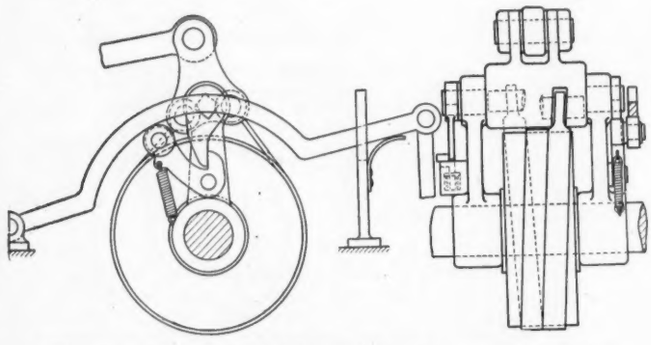


Fig. 11—Meischke-Smith variable throw transmission

H. E. Williams of Portsmouth, England, obtained a patent in 1909 on a variable speed gear in which use is made of a crank of variable throw, and the patent relates particularly to the means for varying the throw while the device is in operation. Referring to Fig. 12, there are two concentric shafts, of which the outer one *B* on its right-hand end carries a disk *C*, forming a guide for the slide carrying the crank pin *D*. The inner shaft *A* carries an eccentric, and a strap *E* on this eccentric connects to a pin *F* on the slide *G*, so that if the inner shaft is moved angularly with relation to the outer, the eccentricity and the throw of the crank pin will be varied.

This relative angular motion is accomplished by providing the inside shaft with a square thread *H* at its left end, with which engages a nut *I* which can move longitudinally with relation to the outer shaft *B* but cannot turn relative to it. This nut is moved along the outer shaft by means of a shifter fork and thus rotates the eccentric relative to the guide for the slide and changes the throw of the crank pin. The crank pin is surrounded by a ball bearing collar *J* from which there are link and lever connections to the shafts of four spur gears, arranged concentrically around the driving shaft. These mesh with a pinion *K* on the sleeve *L* on which the differential side gears *MM* are mounted freely. Both of these side gears can be placed in driving relation with the sleeve, for forward and backward motion respectively. These two gears mesh with the driven gear *N*. The levers *O* on the shafts of the four gears evidently have a rocking motion, and it would seem necessary to provide some kind of ratchet device at this point, but the inventor says that they tend to turn the spur gears always in one direction. But, as stated, the patent relates specifically to the means for varying the throw of the crank pin, which are plain enough.

One inventor who gave a good deal of attention to variable throw transmissions is H. W. Fellows of Los Angeles. His method for obtaining a variable throw is illustrated in Fig. 13. The connecting rod from a crank pin on his engine shaft connects to the middle point of a sort of toggle linkage. One end of the link connects to a lug on a rocking drum and the other through a short link to an adjustable fulcrum, so that the revolution of the engine crank pin will more or less straighten the toggle links and give a rocking motion of more or less amplitude to the drum.

This rocking motion is converted into a continuous rotary motion by means of a grooved friction disk and eccentrically mounted friction rollers engaging therewith. The position of the eccentrics determines which of the strokes shall cause motion to be imparted to the friction disk and which shall be an idle stroke. By means of a sliding collar on the driven shaft the relation of the eccentrics to the lines of centers of the friction rollers and disk can be changed and thus the direction of driving motion reversed.

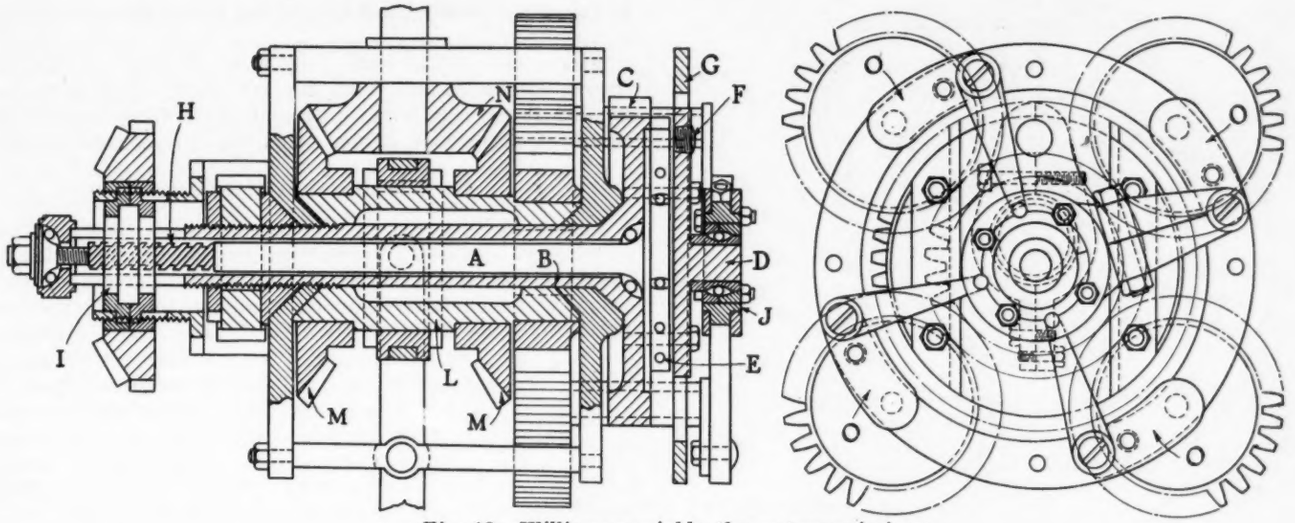


Fig. 12—Williams variable throw transmission

Fellows worked out several different designs of variable throw transmission, covered by a number of different patents, and organized a company to manufacture them, the Fellows Direct Power Transmission Co. of Los Angeles.

In 1906 Paul Weeks of Los Angeles took out and assigned to the Fellows Direct Power Transmission Co. a patent which covered improvements in the change speed mechanism previously built by that concern. The particular objects of the improvement were to render the mechanism more compact, to incase it so it could be run in a bath of oil and to make it possible to reduce the stroke of the driven member to nothing when the parts were in the neutral position. Referring to Fig. 14, the similarity of this transmission to the Fellows, Fig. 13, is apparent. The connection from the driving crank to the ratchet mechanism in this case is made by a toggle device, the center joint of which connects by an adjusting link *A* to a sliding block *B* formed with a shoe adapted to travel in a guide and to be moved along that guide by means of a threaded rod *C* passing through the shoe, and a pair of bevel gears *D* for rotating the rod from a cross shaft. When the sliding block *B* is adjusted as shown in the illustration, the center joint will describe the curve *a* in the drawing and the driving pawls then have their maximum stroke; whereas when the block is adjusted as far to the right as possible, the center joint describes the path *b* and the stroke of driving pawls is then reduced to zero.

In a patent issued in 1915, the patentee, John Reece of Manchester, Mass., says that in transmittig mechanisms of the intermittent gripper type, known so far, the driving action of the gripper has not been effective because of failure to provide a constant angular velocity of the

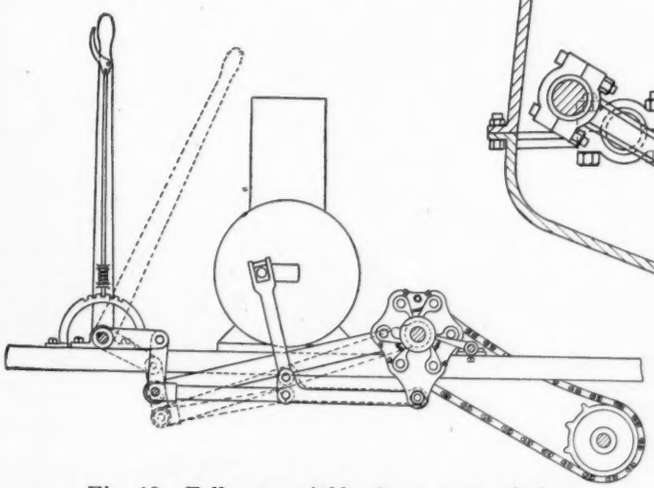


Fig. 13—Fellows variable throw transmission

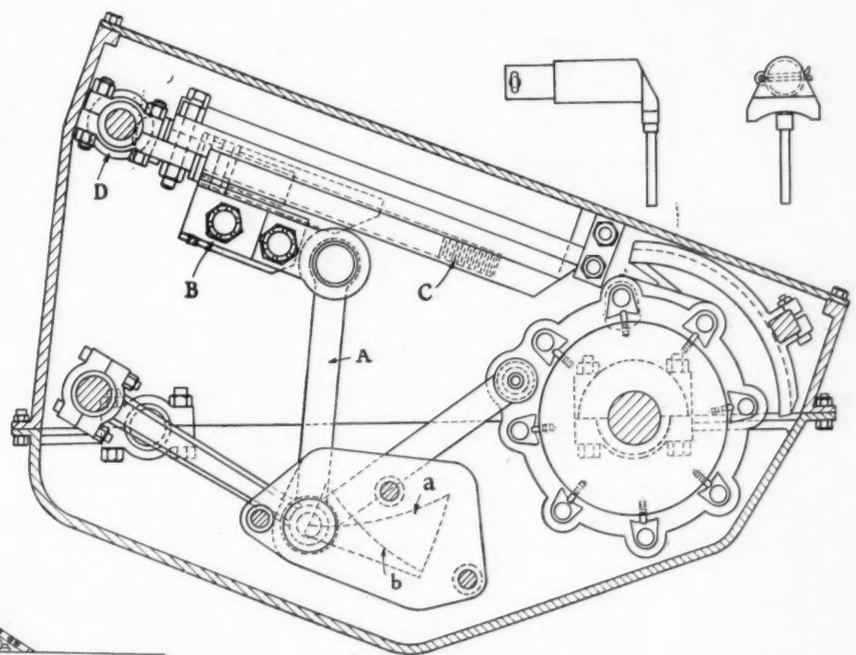


Fig. 14—Weeks improvement on the Fellows transmission

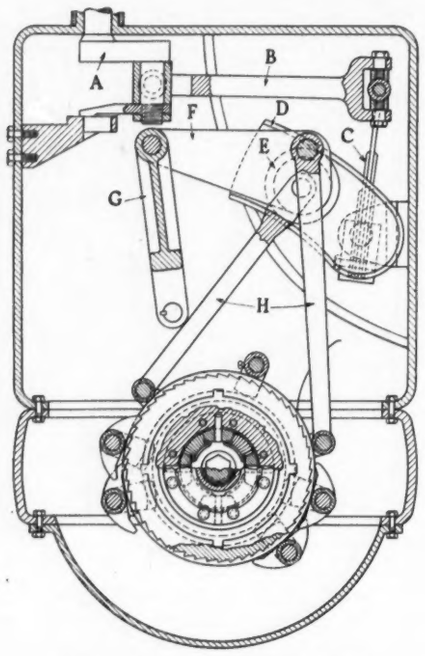


Fig. 15 — Reece variable throw transmission with flexible oscillating arm and pawl and ratchet drive

gripper during its driving stroke. Owing to the inertia of the driven parts the gripper will drive only when moving at its maximum speed, and as this speed is maintained only for an instant the efficiency of transmission is low and the strains on the parts are very great. This defect could be overcome to an extent by employing a large number of grippers in suitable phase relation, but such a device would be complicated and therefore impractical. He therefore set himself the problem of securing with a minimum number of grippers a maximum percentage of uniform gripper speed and driving action.

Reece Transmissions

As shown in the drawing, the transmission, which may be combined with the rear axle, comprises a crankshaft *A* through which a rocking motion is imparted to a bell crank construction through a connecting rod *B*. One arm *C* of this bell crank, that jointed to the connecting rod, is in the form of a leaf spring, while the other, *D*, forms a curved track for the roller *E*. The roller is held in position in the track by means of a link *F* depending from a lever *G*, from which latter a suitable connection is made to a control lever or handle, and the rocking motion of the roller naturally depends upon its position in the track. From the support of the roller there extend two reciprocating rods *HH* to the rear axle, with which they are placed in driving relation by means of a pawl and ratchet mechanism. One of the rods evidently transmits power while in tension and the other while in compression, and in order to insure a still further degree of uniformity in the transmission of power, the track and roller device, as well as the reciprocating rods, may be duplicated and an additional set of ratchet mechanisms provided. The essentially novel feature in this patent appears to be the rocking lever in the form of a flat spring which tends to keep the driving force on the circumference of the ratchet wheel substantially constant during a considerable portion of its stroke.

Reece took out at least four other patents on variable throw transmissions, but the one here abstracted was applied for at the latest date and evidently embodied the result of experience gained with the earlier construction.

De Martino's Transmission

Joseph de Martino of Chicago in 1919 took out two patents on a power transmitting mechanism in which an adjustable eccentric on the driving shaft is combined with one-way drive clutches or ball ratchets on intermediary shafts. In one of the constructions (Fig. 16) the driving shaft *A* is made hollow and a rod *B* passes through it, which, by means of an inclined link *C* extending through a slot in the wall of the hollow shaft, moves the eccentric *D* on this shaft into positions of greater or less eccentricity. The eccentric carries two straps and eccentric rods *EE* which connect to crank arms *FF* on intermediary shafts *GG*, giving these shafts an oscillating motion of an amplitude depending upon the degree of eccentricity. These intermediary shafts carry the roller ratchets *HH* through which the two wheel gears *II* are driven, and these gears mesh with another gear *J* on the driven shaft, which latter is concentric with and secured to the driving shaft.

A good feature of this construction is the compact arrangement of the mechanism, but there are evidently several weak points, such as the adjustment of the eccentric by means of an inclined link and pull rod, which appears entirely impractical. This difficulty seems to have been realized by de Martino, who attempted to overcome it in his later application, in which he proposed to vary the eccentricity by means of a sliding cam inside the driving shaft.

A rather unique form of automatic variable throw mechanism was patented by Georges L'Hermitte of Nantes,

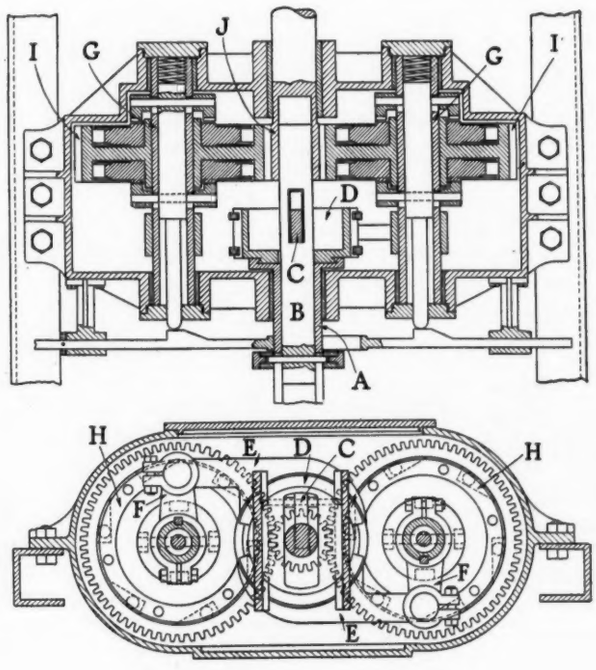


Fig. 16—De Martino's variable throw transmission

France, in 1922. Referring to Fig. 17, he makes use of a driving shaft *A* on which there is a crank *B* in the form of a guide, along which a bearing block *C* may slide. This bearing block contains the end of a rod *D* which is given a conical motion by the crank. The rod *D* is connected at its upper end to two horizontal shafts at right angles to each other, of which only one, *E*, can be seen in the drawing. The connection between the rod and these shafts is of the universal type (by means of gimbal rings) and the conical motion of the rod imparts to the connected shafts an oscillatory motion, the amplitude of the oscillations being measured by the angle of the cone elements of the conical motion. The driven shafts *E* connect through friction pawls *F* with bevel gears *G* mounted loosely upon them, by which means the oscillatory motion of the shafts is converted into continuous rotary motion of the gears, and all of the gears (four) mesh with a common bevel gear *H*, the shaft of which is the driven shaft.

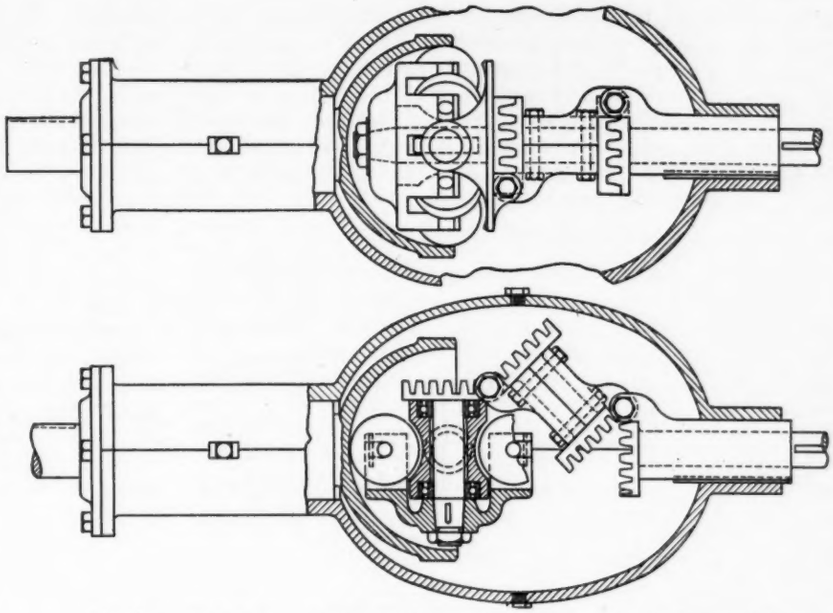


Fig. 18—*One form of the Weiss continuously variable transmission*

Two methods for automatically changing the gear ratio in accordance with the torque requirements of the vehicle are indicated in the patent, and are illustrated by the two detail views in Fig. 17. The first depends upon the fact that as the driving resistance increases the engine speed will be pulled down. The bearing block *C* in the driving crank *B* forms virtually a centrifugal mass and tends to move to the outer end of the slot in the crank under the influence of centrifugal forces on it. This force is counteracted by a coiled spring *I* lodged within the hollow driving shaft, the pressure of which is transmitted to the bearing block through a suitable linkage, *K, L, M*. As the speed of the driving shaft increases the bearing block will move farther out in the slot on the crank, compressing its counteracting spring more, and vice versa. This, therefore, is an example of transmissions in which the ratio is changed by centrifugal force.

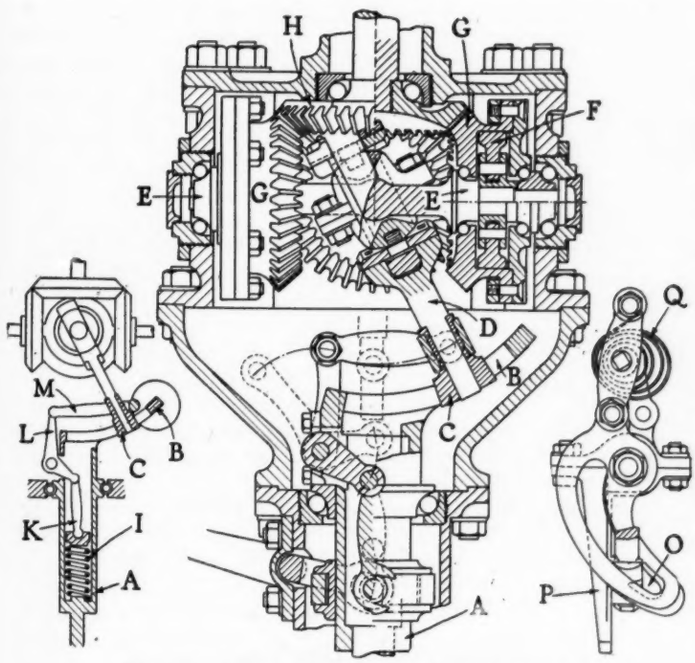


Fig. 17—*L'Hermitte automatic continuously variable transmission*

By the other method the slot *O* in the crank arm is given a spiral formation and a lever arm *P* under the force of a spiral spring *Q* tends to force it to the outer end of the slot in the crank, whereas the reaction between the bearing block and the side of the slot tends to force the bearing block toward the inner end of the slot. The reaction between block and slot increases with the amount of torque transmitted; hence, if the torque increases, the block will move toward the inner end of the slot and the throw will be decreased.

Some time ago we described in AUTOMOTIVE INDUSTRIES a transmission invented by Carl W. Weiss of New York. Mr. Weiss took out quite a number of patents, beginning in 1915, all relating to transmissions of the same general character. In these transmissions use is made of a driven member carrying a series of annular ball bearings whose outer races are adapted to enter into frictional contact with the inner surface of a hollow hemispherical member. The angular relation of the hemispherical driving member and of the driven member carrying the ball bearings can be changed, the two parts being co-axial in one extreme position and at right angles to each other in the other.

A patent taken out in 1923 covers two features of a later design. One of these has to do with the means for creating pressure between the driving and driven parts. This is accomplished by moving the driving hemispherical part axially into contact with the driven part, by means which are obvious from the drawing herewith.

Another feature consists of means employed for connecting the driven part of the transmission with the driven shaft in such a way that the driven part may be swung through an angle of 90 deg., so that both a direct through drive and a disengagement of driving and

driven members may be accomplished. To this end use is made of an intermediary member provided at both ends with a flange with teeth projecting from it laterally. This intermediary member is hinged to both the driven part of the transmission and to the driven shaft. In the direct through drive position the torque transmitted is taken on the teeth of the flanges, while in other positions it is taken on the hinges and hinge bolts.

Driscoll's Transmission

Daniel W. Driscoll of New York in 1923 obtained a patent on a variable speed transmission of which he says in his specification that it is applicable to "the entire automotive field" and to many other uses, which he enumerates. The driving shaft *A* is provided with two cranks set opposite each other, which impart an oscillating motion to two levers *BB* which straddle the crank pins and are pivoted on a pivot block which, by means of the lever *C* and suitable links *D*, can be adjusted vertically in the pedestal *E*. With a constant throw of the cranks a change in the center distance *d* between the crank and the oscillating lever pivot will, of course, result in a change of the amplitude of oscillation of the levers *BB*.

The oscillations of levers *BB* are transferred to two other levers *FF*, which are pivoted at the top of the housing. The first oscillating lever *B* at the left connects with the lever *F* farthest to the right through the intermediary of a shaft *G* journaled in the base of the pedestal and two levers *HH* thereon, which carry sliding blocks adapted to slide in the slotted levers; whereas the two intermediary oscillating levers are connected together directly by means of a pin *I* projecting laterally from the lower end of one into a bearing block in the end of the other.

From the two levers *FF* an oscillating motion is transmitted to two concentric shafts by means of crank arms *JJ* and slide blocks or by means of curved racks and gears. The oscillations of these shafts are converted into rotary motion by means of so-called impellers (the mechanism included between the two large ball bearings *P*). These are friction shoes located inside a drum, with which they are pressed into driving engagement by eccentrics on the oscillating shafts. A direct drive is also provided, operated by the lever *K* shown on the right, by means of which the driving and driven shafts can be coupled together directly, the driving shaft extending through the impeller and abutting the driven shaft.

One of the latest variable throw automatic transmissions to be developed is that of the French engineer De Lavaud, which has been adopted by the French automobile manufacturer Voisin. A sectional view of this device is shown in Fig. 20. It consists essentially of a wabble plate, the angularity of which to its driving shaft can be changed; a pair of connecting rods extending from the wabble plate to the rear axle, and of ball ratchets on the differential on the rear axle.

In the illustration shaft *A* is an extension of the engine crankshaft which, as shown at *P*, is lozenge-shaped when seen in longitudinal section, and rectangular in transverse section. The sleeve *B*, with a rectangular slot, is mounted on the shaft, rotating with it and capable of sliding on it. It is guided in its sliding movement by two pivots, *O* and *S*, fixed to the sleeve and moving in the openings *O'* and *S'* in the shaft *A*. Two ball bearings mounted on sleeve *B* carry the plate *C*, which is concentric with the sleeve. On plate *C* there are a series of ball-ended posts *D*, on which are fulcrumed connecting rods *E*, each one of which has its opposite end *G* connected to a ball-ratchet *N*. These ball ratchets drive the hub *M* in the direction indicated by the arrow *f*. On plate *C* are two diametrically opposed trunnions *H* pivoting on ring *F*. This ring is fitted with two other opposed trunnions in a plane perpendicular to trunnions *H* and pivoting on the fork *L*. This fork can move longitudinally but it cannot revolve, and near its end it is provided with a collar against which presses a coil spring or series of spring washers *K* bearing eccentrically against the rear axle housing.

When shaft *A* revolves it carries with it sleeve *B*, the axis of which describes a cone around the axis of shaft *A*. The sleeve performs its conical motion inside plate *C*, which is prevented from turning by being connected by trunnions *H* to ring *F*; the latter in turn is connected by trunnions to fork *L*, which cannot revolve. This causes plate *C* to oscillate, as indicated by arrows f_1, f_2, the oscillations of adjacent rods differing in phase.

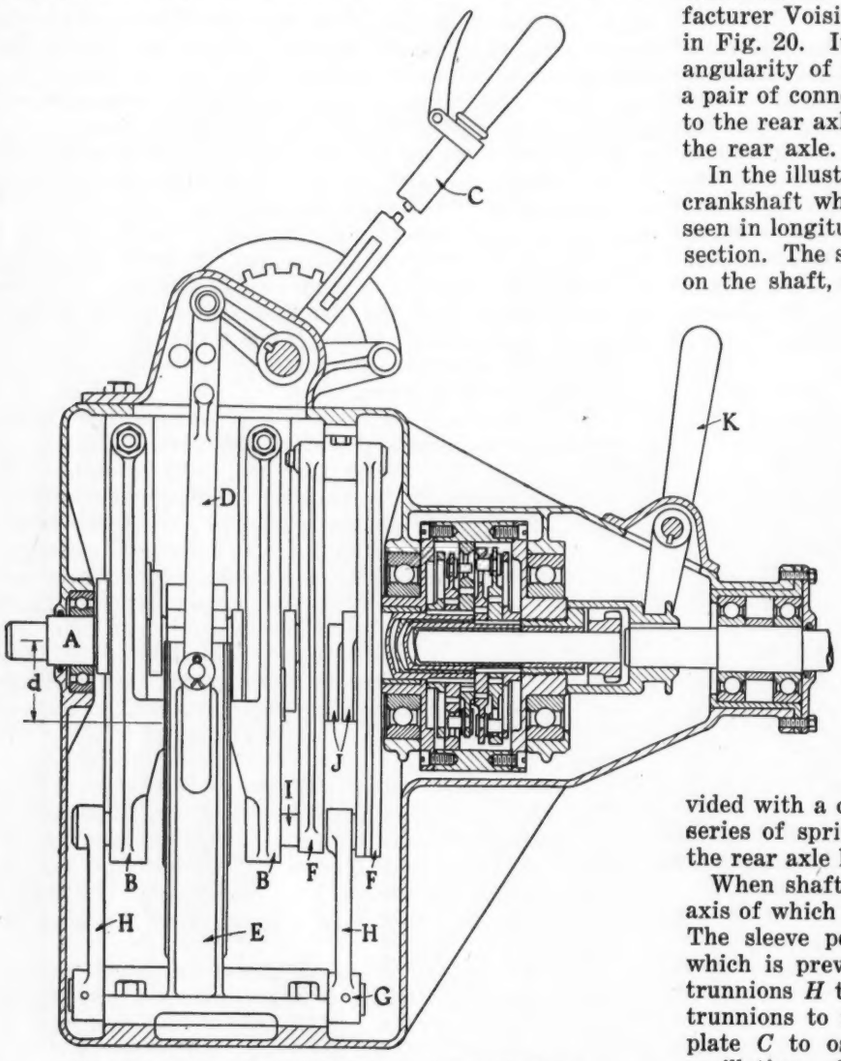


Fig. 19—Driscoll variable throw transmission

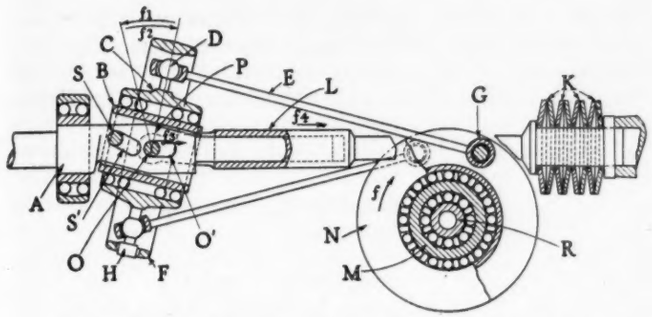


Fig. 20—De Lavaud variable throw transmission

The oscillating movement being transmitted by each rod to its corresponding ball ratchet *N*, a series of impulses in quick succession is given to the hub *M* and through it to the road wheels.

When the resistance at the road wheels increases, the load on the connecting rods is increased in the same proportion, and in consequence there is a reaction on plate *C*. Under this reaction plate *C* tends to take up a position perpendicular to the axis of shaft *A*. Trunnion *O* is moved toward the right of the figure, carrying with it the fork *L*, which through the collar compresses spring *K*. The degree of compression of spring *K*, therefore, measures on a convenient scale the value of the resisting moment which the engine torque must overcome.

Inertia Mass Type Transmission Developed

ONE form of automatic transmission comprising an intermediary inertia member was described in the early part of this article. Considerable attention has been called to this type recently by the writings of G. Constantinesco, inventor of the C.C. gun synchronizer. Constantinesco has published a crude sketch of this type of transmission, showing an ordinary pendulum linked to a balance lever, the center of which lever connects by a link to the driving crank shaft and the other end through a pair of links or connecting rods with a ratchet device on the rear axle.

Constantinesco claims to have invented a transmission of this type in which oscillating flywheels are used instead of the pendulum, and he has written a series of articles on the subject of torque conversion by the use of inertia members, couched in abstract mathematical phraseology, but has so far carefully guarded the details of his device. Very creditable development work in this direction has been done by Wilfred Hunt of Hillhead, Glasgow, Scotland. Hunt took out a series of three U. S. patents on transmissions of this type during a period of six years, and his patent specifications reflect a thorough knowledge of the mechanical principles involved and of good engineering practice, which is more than can be said of the average patent. As this type of transmission is so novel, the writer considered it worth while to abstract all three of Hunt's patents.

The first patent, issued in 1915, covers a transmission embodying three separate members, a driving member, a driven member and an inertia member between them, the inertia member being in the form of flywheels and rigidly connected to the driving and driven members (see Fig. 21). The inertia masses are oscillated in proportion to the difference between the speeds of the driving and the driven members.

All of the members are arranged concentrically, and to insure balanced running and uniform torque the masses are made to oscillate in successive even phase and their number is made such that their oscillations overlap.

Referring to the drawings, there are three flywheels *A*, which are freely pivoted on an extension *B* of the driving shaft. On this shaft is a spider *C* rigidly coupled to a second spider C_1 by bolts *D* passed through long bosses *E* on each, which bosses also serve to hold between their adjacent ends a three-armed supporting bracket *F* for the ends of the driving shaft. Between the spiders *C* and C_1 are three bearing bolts *G*, spaced 120 deg. apart. On these bearing bolts are sleeves *H* with lugs *I*. Hinged to each lug are pairs *J* of flat levers, each straddling a flywheel (and curved to clear its hubs in their swing), and each connected to the flywheel it straddles by a link *K*, pivoted to the flywheel at the edge of a clearance gap *L* in it. The sleeves *H* also have levers *M* formed on them at their ends remote from the driving shaft. To the ends of these levers are pivoted pairs of links *N*, attached by bolts *O* to a common head *P* rotatable on the pin *Q* of a crank

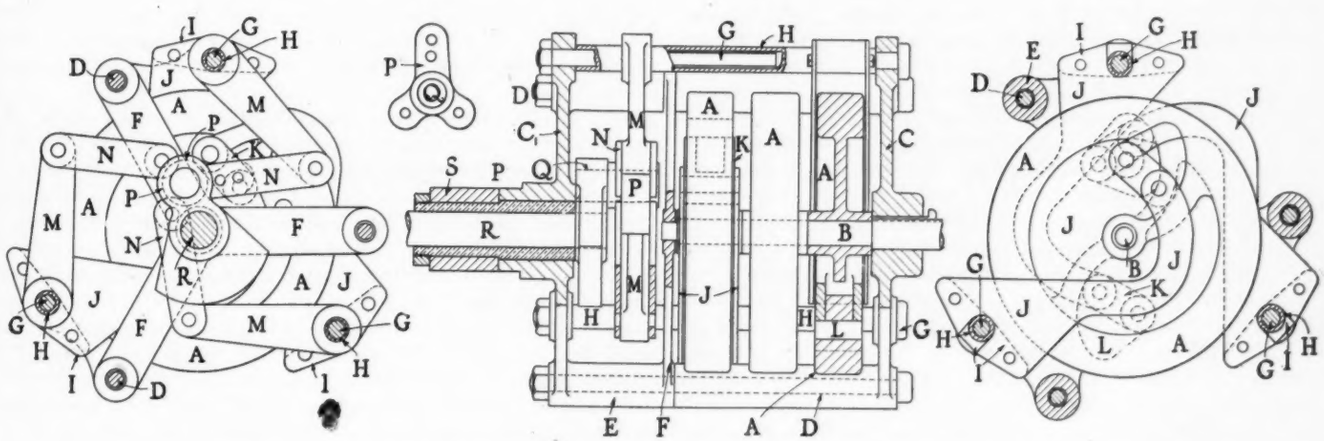


Fig. 21—Hunt's earliest type of inertia mass transmission. On left, cross section showing connection of oscillating sleeves to sleeve on crank of driving shaft; in center, longitudinal sectional view; on right, cross section showing connection between oscillating sleeves and flywheels

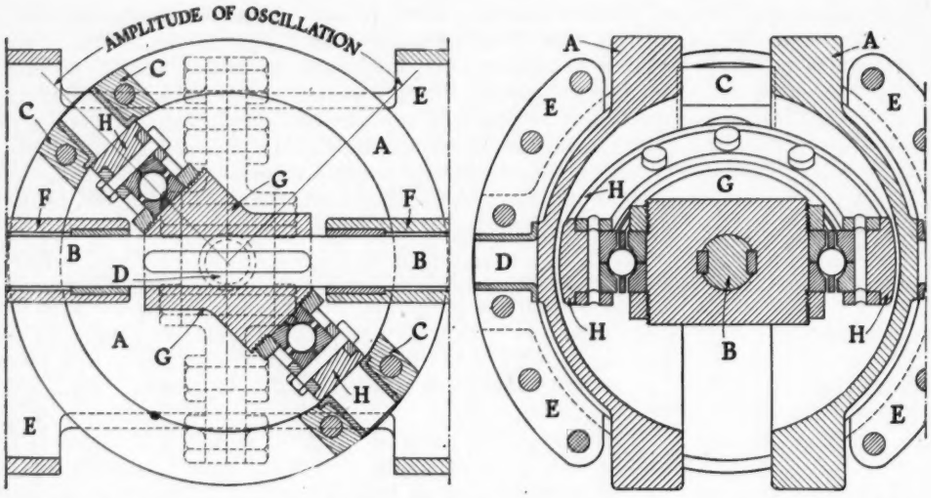


Fig. 22—One unit of Hunt's second form of transmission, comprising a double flywheel rotating on an axis at 45 deg. to the axis of the driving shaft and the housing. Three of these units were to be used in each transmission

on the end of the driven shaft *R*, which shaft runs within a sleeve clamped in a fixed bearing *S*.

Let us suppose, now, that the driven shaft *R* be held stationary and the driving shaft *B* be rotated through one revolution, carrying with it the spiders *C* and C_1; then the crank pin *Q*, through the links *N* and levers *M*, will cause an oscillation of the sleeves *H* to take place during this revolution. This oscillation is transferred by the pairs of levers *J* to the flywheels *A*. As the sleeves *H* are spaced 120 deg. apart, the oscillations of the flywheels (of an amplitude of approximately 120 deg.) will succeed one another in evenly-spaced and overlapping phase. It will be seen that if the driven shaft *R* be turning, as well as the driving shaft *B*, but at a lower speed, one oscillation of each of the three flywheels will take place for each revolution of difference between the speeds of the shafts.

The inventor explains that the mechanism described is perfectly feasible, but that for certain applications it has a disadvantage in that the torque in the driven shaft is proportional to the square of the speed of oscillation of the flywheels, which is the difference between the speeds of the driving and driven shafts. Therefore, if the speed of the driving shaft is constant and the speed of the driven shaft decreases in a certain proportion, the torque on the driven shaft will increase as the square of the inverse of that proportion; and since the decrease in speed and increase in torque of the driven shaft are not reciprocals, there must be a change in the torque on the driving shaft. This change in the driving torque required may be obviated by the interposition of a planetary gear train of the internal gear type.

Hunt seems to have encountered two difficulties with the form of automatic transmission above described, which he outlines in a further specification forming part of a patent issued to him in 1919, as follows:

"In the earlier construction connecting rod obliquity is present, and the acceleration and deceleration periods therefore are not equal. In dealing with an intractable force such as inertia, which varies as the squares of the velocities involved, such an irregularity becomes marked. In the earlier construction, also, the axes of the inertia units (flywheels) coincided with the axes of the driving and driven shafts. These flywheels then have a composite motion, an oscillating motion being superimposed upon a steady rotary motion. The result of this is that the forces due to the oscillation are to a certain extent modified by those due to rotation, with the result that there is not exact equality in the power capacity of those parts of the cycle of oscillation in which oscillation is in the direction of rotation and those parts in which oscillation is contrary to the direction of rotation, the power capacity during the first parts being greater than during the last. The result of this is that unless there is a large number of inertia units there is considerable variation in torque."

To overcome these difficulties Hunt placed the inertia units with their axes at an angle with the axes of the driving and driven shafts and oscillated them by means other than connecting rods. Fig. 22 shows two sectional views of a unit of which it is proposed to use three in the transmission, placed end to end and rigidly assembled together. The unit comprises a central shaft and a housing, and either of these may be the driven part.

Description of Hunt Transmission

Referring to the drawings, a pair of flywheels *A* are provided, which straddle the shaft *B* and are rigidly connected together by the blocks *C*. On the flywheels are trunnion pins *D* carried in bearings formed between the halves of the casing *E*, which also carries the bearings *F* for the shaft *B*. On shaft *B* is keyed a block *G*, forming a "swash block" or wabble plate which has a cylindrical surface, the axis of which is inclined at 45 deg. to the axis of shaft *B*. Upon this swash block is mounted the inner race of an annular ball bearing, the outer race of which is secured in a gimbal ring or universal joint ring *H*. This ring is formed with trunnion pins located in bearings in the blocks *C* connecting the flywheels *A*. In this case the flywheels, of course, will oscillate through an angle of 90 deg., and the frequency of oscillation will depend upon the differenece in the rotative speeds of the central shaft and the housing, as the flywheels, owing to their trunnion support in the housing, must rotate with the latter.

While this newer device undoubtedly overcame some of the difficulties encountered with the earlier one, it led to a much more bulky construction. In the earlier device the three flywheels were located on a common axis side by side and therefore occupied but little space, but in the newer one they were placed end to end, on a common shaft, so the total length was somewhat greater than three times the flywheel diameter.

In a patent issued to Hunt in 1920 a transmission is described for which it is claimed that complete uniformity of transmission is obtained with a single inertia unit. This single mass is arranged with its axis at an angle to and cutting the main axis of rotation.

The inertia mass, mounted on an inclined shaft, is interconnected with the driven member through a device which transmits equally all the impulses of all parts of the

oscillating mass (as Hunt explains it). As there is always a part of that mass in a particular phase—the phase traveling around the mass, as it were—there is a constant absorption of power, a constant transmission of it to the driven member and, consequently, smooth running. Toothed gearing is used for connecting the inertia mass with the driven member.

Simple Form of Inertia Mass Transmission

One form of construction under the 1920 patent is shown in Fig. 23. The driving shaft *A* at the left is secured into the casing *B*, while the driven shaft *C* is supported freely in the casing and extends from it at the right. Mounted in the casing at an angle of 45 deg. to the axis of the driving and driven shafts there is a shaft *D* carrying a spherical rotating mass *E*, which is made in halves as shown. The inclined shaft at one end carries a bevel pinion *F* which meshes with a bevel gear *G* mounted freely on the driven shaft. This bevel gear has formed on its back side an internal gear ring *H* which forms one member of a planetary gearset, the planetary pinions *I*, *I*, being mounted on studs fastened in the end plate of the casing and the central pinion *J* fastened to the driven shaft *C*. One of the essential features of the design is that the gear ratio between the internal gear and the planetaries shall be the reverse of that between the bevel pinion and gear, so the inertia mass and the driving shaft will maintain what the inventor calls "a mean parallelism." The mass then oscillates at a speed equal to the difference between the speeds of the driving and driven shafts and rotates at the speed of the driving shaft. The blocks of material *KL* shown in the corners of the casing are balance weights to balance the inclined shaft and parts thereon, such as the bevel pinion.

Explanation of Principle Involved

The mode of operation of this design may not be directly apparent. The casing, of course, rotates with the driving shaft, and with it the inclined shaft on which the inertia member is mounted. If the driven shaft is held stationary, the planetary pinions will be carried around the central pinion on the driven shaft by the casing and this will cause the internal gear (and the bevel gear formed integral with it) to make one and a half revolutions to every revolution of the casing, and in the same direction (assuming the central pinion to have the same number of teeth as the planetaries).

The bevel gear therefore will make one-half a revolution relative to the housing, and with the bevel gear having twice the number of teeth as the pinion the latter will rotate at the same speed as the housing—if the driven shaft be stationary. If the driven shaft turns, the bevel pinion and the inertia mass connected with it will make one revolution per revolution difference in the speeds of the housing and the driven shaft.

Evidently the housing revolves around its axis at a uniform speed and the inertia mass or flywheel also revolves around its axis at a uniform speed; hence there would seem to be no oscillating mass at all. However, if we take any particle at the equator of the inertia mass, this particle is taking part in revolutions around two different axes at an angle to each other, and owing to this compound motion the absolute speed of the particle varies from instant to instant.

It also may not be directly apparent where the torque originates in this device, as the inertia mass rotates at uniform speed and is not accelerated and decelerated as

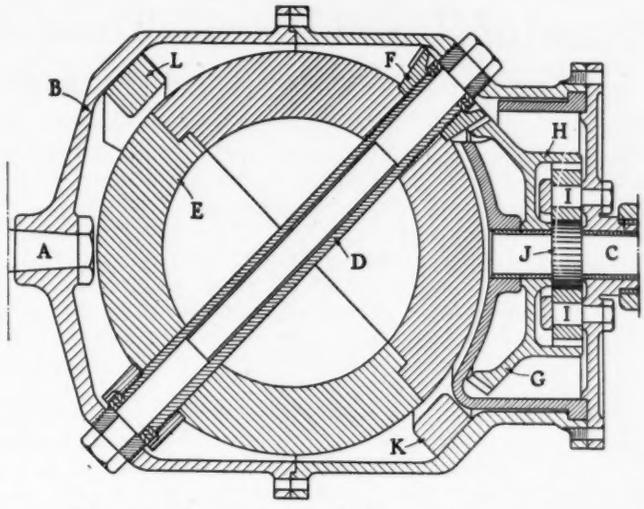


Fig. 23—Hunt's latest design of inertia mass transmission, which is complete in a single unit

a whole, as were the inertia masses in the two previously described transmissions. The mode of action can probably best be understood by regarding the inertia mass as a gyroscope, the axis of rotation of which is moved constantly, because of its fixed angular relation to the rotating housing. It is a well-known fact that a spinning gyroscope offers resistance to a change in the direction of its axis. This resistance varies with the speed of gyration, which in this case is equal to the difference between the speeds of the driving and driven shafts. It is this resistance of the spinning inertia mass to a change in the direction of its axis that is the basis—the point of purchase, say—of the torque on the driven shaft.

Some of the forms of continuously variable transmissions that have been suggested embody the feature of reversibility, while others do not. In all of those transmissions in which the ratio may become zero, theoretically, a further displacement of the part by means of which a change in the gear ratio is effected usually produces reverse motion. This, of course, helps to simplify the mechanism.

Transmissions of the inertia type do not share this property, and with them a separate reverse gear must be provided. A great deal of development work on reversing mechanisms has been done in connection with marine engines, and a simple and compact unit for this purpose could be provided, no doubt.

The question also arises whether it would be necessary to use a friction clutch with an inertia type of transmission. Some sort of disconnecting device evidently would be required, so that the engine could be run when the car was at a standstill, but it would seem that a positive clutch would serve the purpose.

With an inertia mass type of transmission, even if the clutch were engaged, the car would not start from rest with the first revolution of the engine. It would start only after the inertia masses had attained such a speed that the corresponding torque equalled the resisting moment on the propeller shaft, and under ordinary conditions this would occur only after a considerable number of engine revolutions. It would therefore not be necessary for the starting motor to start both the engine and the car, for the engine would have picked up its regular cycle long before the car began to move.

Trend of Recent Designs Toward Gearbox Weight Reduction

THE "shrinkage" in the size of gearboxes referred to in the introductory paragraphs of this article is illustrated aptly by the example of the Oakland, in which the gearbox weight was reduced from 72 to 50 lb. at the beginning of the present season. As one of the means to this end the pitch of the gears was reduced from 6-8 to 7-9, while the ball bearings also were reduced in size.

It is customary to mount the reverse idler in plain bronze bearings, but occasionally flexible roller bearings are used for this part, as in the latest model of La-Fayette.

Transmission brakes, which have to be designed as an integral part of a gearbox, are gaining in popularity, partly, at least, on account of the introduction of four-wheel brakes. When fitted in conjunction with four-wheel brakes the transmission brake is used as the emergency brake. It is often made very small and is provided more as a means for holding a car in position when at rest than for stopping it. To emphasize this fact the term "parking brake" is sometimes applied to it.

Some of the features of gearbox design which have come into extensive use in recent years are the following: Layshaft or secondary gears made in a cluster and mounted on a stationary shaft or stud on either plain or flexible roller bearings; secondary shaft located below the primary; sliding pinion shaft formed with integral splines; shift lever mounted in a spherical support on the gearcase cover; speedometer drive on tail shaft; direct drive clutch of the spur and internal gear type.

Magnetic Gearshift

In line with the general tendency to ease or eliminate the onerous tasks of driving, many efforts have been made to render gear shifting easier, or to entirely remove the need for it. The first system developed with this object in view which achieved a certain measure of success was the magnetic shift. It was used on several cars for a season or two, either as standard equipment or as an extra, but it did not meet with a great deal of popular favor, one of the objections being that the draft on the battery was rather heavy.

This was followed by the mechanical gear shift, of which a number of designs have been developed both in this country and abroad, the best known in this country being the Cutler-Hammer. With such a system there is a selector lever on the steering post or steering wheel, comparable to the spark and throttle levers, by means of which the operator can select a gear he may expect to become necessary to change to, long before the necessity for the shift arrives. Then, when the time comes that he must change to a lower gear, say, all he has to do is to depress his clutch pedal and release it again, the shifting of the proper gears taking place automatically while the clutch is out. The Cutler-Hammer mechanical gearshift is being used on Apperson cars at present.

A different solution of the gear shifting problem is represented by the Chandler Traffic transmission made under Campbell patents. This gearset is not of the sliding pinion but of the sliding key type, all of the gears remaining constantly in mesh. The advantages claimed are that there is no possibility of missing a gear (that is, that any gear can be engaged at any time) and that no particular skill is required to operate the gear.

Shock of Clashing Gears

With the ordinary sliding pinion gearset, difficulty sometimes arises in changing from a higher to a lower gear quickly, unless the car slows up rapidly, as on a steep upgrade. The force of the shock which occurs when the teeth of mating gears clash in this way depends directly on the inertia of the driven part of the friction clutch, and this has been materially decreased in recent years with the widespread adoption of single plate clutches, in which the driven member often consists merely of a thin disk of steel. One manufacturer of a light car using a sliding pinion type of transmission is said to claim that he can engage any gear at any time.

With gearsets of this type, the shock produced when gears are meshed depends upon the inertia of the driven part of the clutch and of the members rigidly connected thereto, and upon the difference in the pitchline velocities of the gears meshed. To effect easy meshing, the operator usually attempts to equalize the pitchline velocities before enmeshing the gears, by allowing the car to slow down, by speeding up the clutch driven member by bringing it into contact with the driving member momentarily after it has once been released, or by slowing down the driven member by means of the clutch brake.

Another factor affecting the ease of meshing is the chamfering of the ends of the teeth. The greater the chamfer of the teeth the more certain the engagement irrespective of differences in pitch line velocities. If all of the gears had an even number of teeth it would be possible to make the engagement positive by cutting away a short portion of the length of alternate teeth, following a practice employed in connection with gear type clutches.

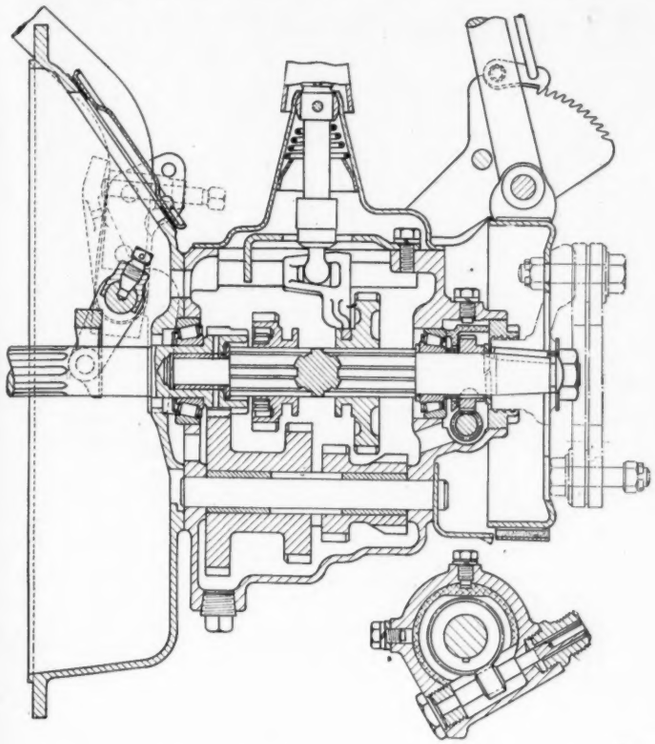
Some of the latest designs of gearboxes are illustrated herewith.

Now and then we hear of hydraulic and electric transmissions, but so far as passenger cars are concerned their possible field seems to be decidedly limited. Those whose memory in the automobile line dates back some five years or more will remember the Owen magnetic car, which had an electric transmission, and a car with the same feature, the Maybach, is still being manufactured in Germany.

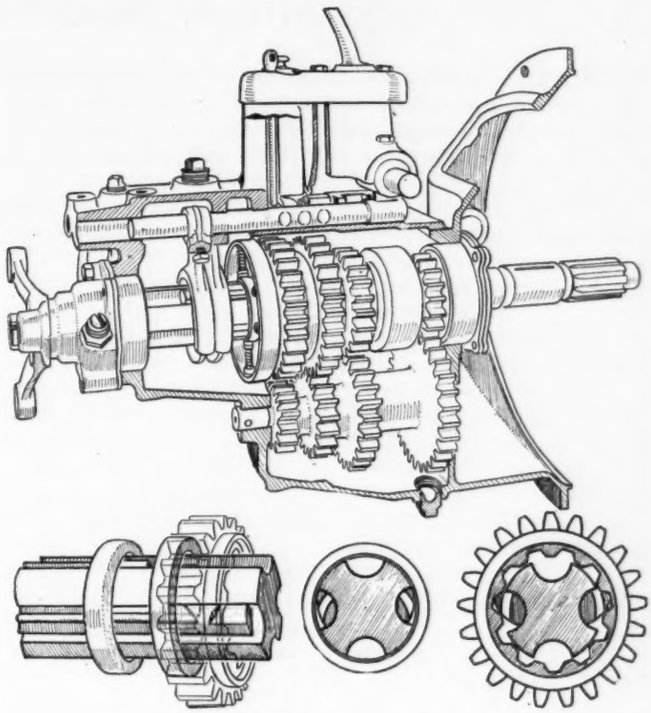
The chief advantages of the electric transmission are that it gives a large number of speed gradations and does away with gear shifting and gear noise. The chief disadvantage is the great weight of the electrical apparatus, while the losses in transmission at ordinary speeds, when there might be a direct through drive, are also objectionable.

It is exceedingly difficult to get from electric motors with one and the same gear ratio, both the maximum car speed and the maximum torque required, and if a mechanical change gear has to be combined with the electric transmission, it complicates matters and certainly takes away some of the appeal which the exclusively electric drive would have.

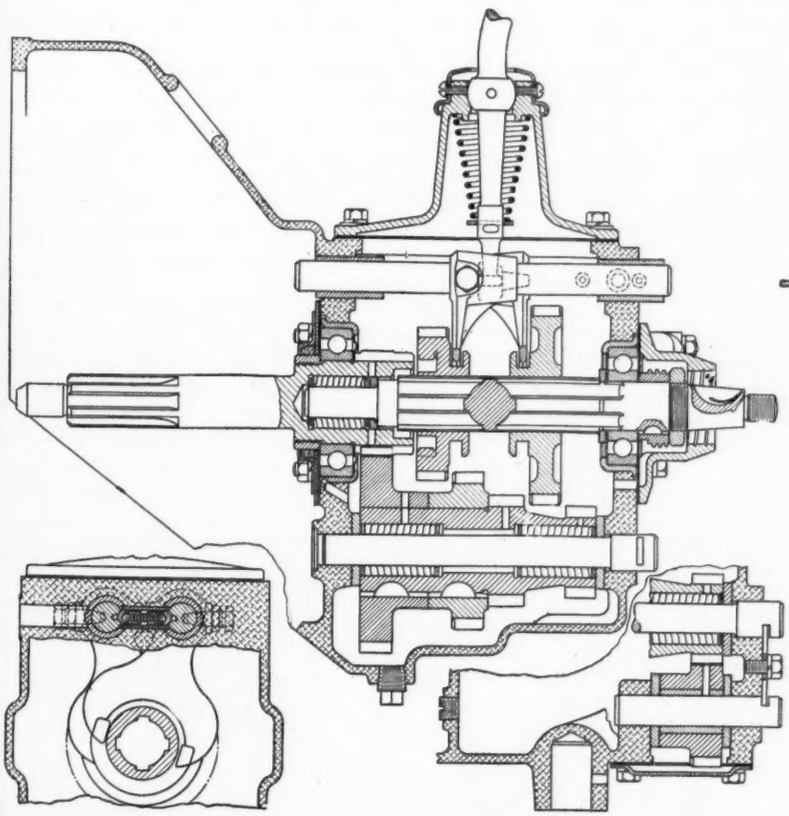
With hydraulic transmissions there appears to be no difficulty in getting sufficient torque, the disadvantages being the very considerable losses as long as the power is transmitted hydraulically, and the danger of developing leaks under low speed, high pressure conditions.



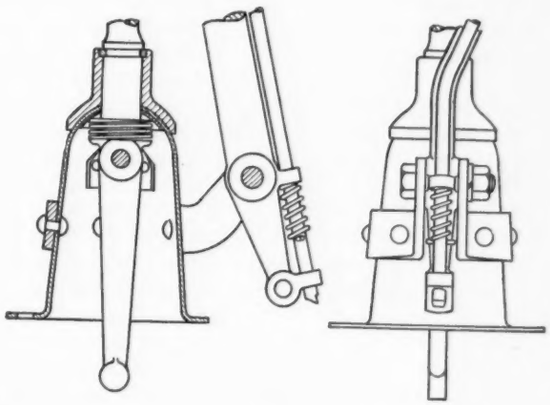
The transmission of the Gray car, which is the smallest sliding pinion transmission in production in this country



Perspective assembly view and details of the Chandler Traffic transmission, one of the few gearsets not of the sliding pinion type now in use



On the left is a section of the Hupmobile transmission, redesigned about a year ago, and two detail views



Two views of the arrangement of the control levers on the Chevrolet, which represents a recent change in design

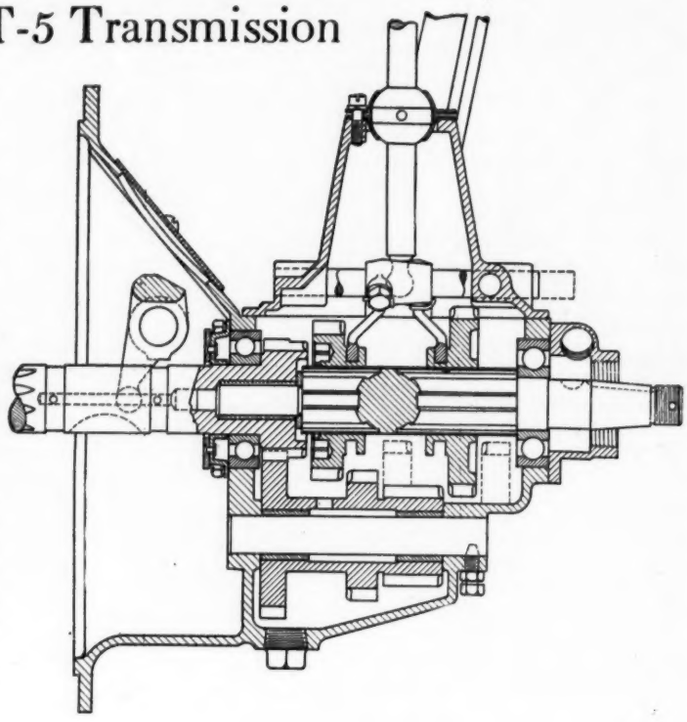
Muncie Model T-5 Transmission

THE latest addition to the line of the Muncie Gear Works, Muncie, Ind., is the Model T-5, a unit power-plant type, three-speed selective transmission made to fit S. A. E. bell housing No. 3, 4 or 5 and arranged for a single plate clutch.

The gears and shafts are made of chrome nickel steel (No. 3120), case-hardened. The main shaft is mounted on ball bearings while the cluster gear is provided with bronze bushings submerged in oil, as is also the reverse idler. It will be noticed that the shaft on which the pinions slide is cut with six splines and has a plain pilot bearing in the clutch shaft.

The shifting forks and brake lever are drop forgings, while the ball and socket gear shift lever is turned from the bar. The conventional position finder and interlocks are provided. The brake lever is of the thumb button type, with hardened latch and ratchet. Both levers are finished in black enamel, the ball on the gear shift lever being of hard rubber and the handle of the brake lever nickeled. A transmission brake and speedometer drive housing can be provided at the rear of the transmission if desired.

This tranmission is designed to take care of a maximum engine torque of 165 lb.-ft.



Peck Transmission Has New Features

WILLIAM W. PECK of Muncie, Ind., has designed and patented a sliding pinion gearset for which he claims several advantages over the conventional designs. No running gears are in mesh when the gear is either in the direct drive or the neutral position. No separate idler gear is required for the reverse, as the reverse motion is obtained by means of the gears used for the first and second forward speeds, meshed in a different way than for forward motion. No constant mesh gears are employed, hence noise due to those gears and resulting wear of the teeth and the bearings, as well as power loss due to churning of the oil by the gears on the secondary shaft when on direct drive, are eliminated.

The accompanying drawings show a plan view and an end view of the gear assembly. Both the driving shaft *H* and the driven shaft *I* are splined, and they are mounted co-axially. Below these splined shafts and on opposite sides thereof are two countershafts *K* and *J*, each of which carries a spool gear rotating freely upon it and adapted to slide lengthwise.

For the first speed forward, the spool gear *C-D* on countershaft *J* is shifted toward the right (or forward) until *D* meshes with *G* (a single sliding pinion on the driving shaft) and *C* meshes with *E*, one member of a spool gear *E-F* on the driven shaft.

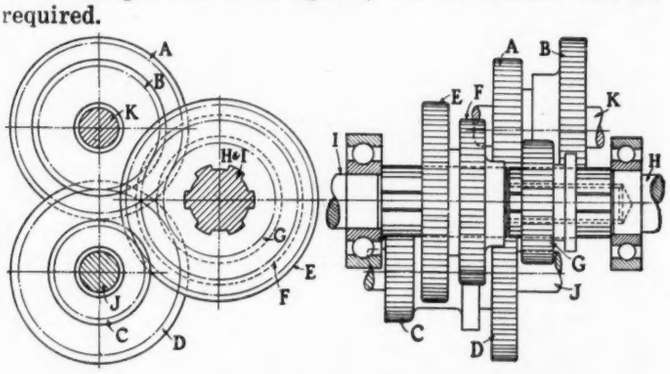
For the second speed the spool *A-B* is shifted to the left or rear until *B* meshes with *G* and *A* with *F*.

For the reverse, pinion *G* is shifted to the right or forward until it meshes with *B*, and spool *E-F* is simultaneously shifted to the left or rear till *E* meshes with *C*. Assuming that pinion *G* rotates right-handedly, spool *A-B* will rotate left-handedly, spool *C-D* right-handedly and spool *E-F* on the driven shaft left-handedly, that is, in the reverse direction to the driving shaft.

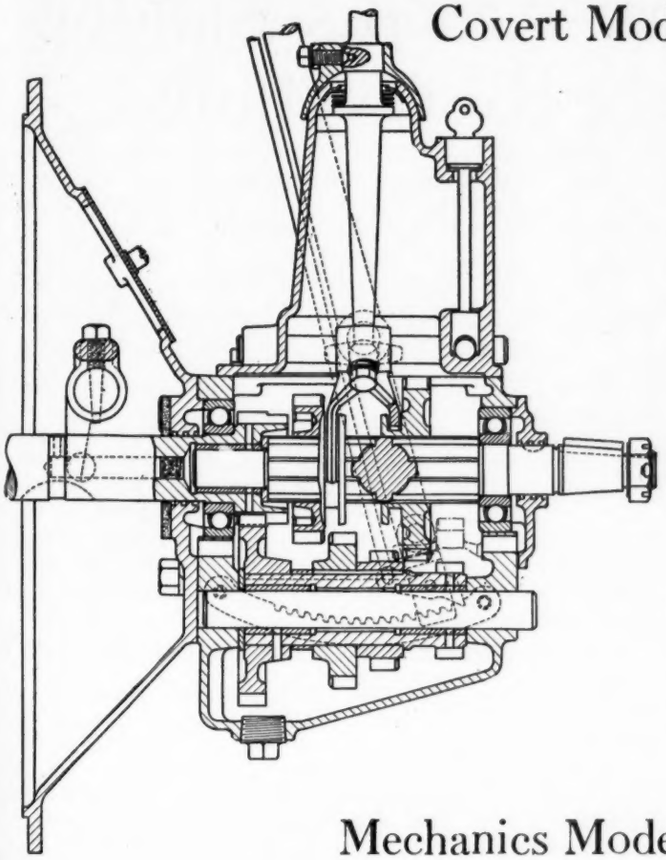
By moving all gears forward and maintaing the neutral spacing, spool *E-F* moves partly off the driven splined shaft onto the driving splined shaft, thereby effecting the direct drive. The gears are so spaced that meshing between the driving pinion *G* and its mating gear occurs slightly earlier than meshing of the other pair of the train, of which one may be stationary.

Gearshifting is effected by means of a ball-mounted, ball-handled lever, and the different sliding sets are properly interlocked so there is no possibility of engaging two speeds at the same time.

There are only seven gears in this transmission, as compared with eight in the conventional three-speed gearbox, and the inventor claims that for a gear of average capacity the shafts and the case are about 1 in. shorter. The shifter forks are of flat pressed steel, bent to shape to fit the grooves of the gears, and no shifter rods are required.



Covert Model E-3-B Transmission



A GEARSET for passenger cars of up to 125 lb.-ft. engine torque, made by the Covert Gear Co., Inc., Lockport, N. Y., is shown in section by the accompanying drawing. It fits the S.A.E. No. 3 bell housing, but the same gearset is also made with other flanges to fit both the No. 4 and No. 5 bell housings. The four-splined shaft has a bushed pilot bearing in the clutch shaft. Both ends of the primary shaft are carried in annular ball bearings, while the cluster gear on the secondary shaft is fitted with two plain bearings and rotates on the stationary stud.

This gearset, of course, gives three forward speeds. The reduction on the intermediary gears is 1.7 to 1; that on the low gears 2.86 to 1 and that on the reverse 3.57 to 1. The gears are made of 3½ per cent nickel case hardening steel with ⅝ in. width of face and with 6-8 pitch teeth. At the rear end of the driven shaft a taper seat is provided for the universal joint, with a maximum diameter of 1¼ in. and tapering 1½ in. per foot.

A sheet metal inspection cover for the clutch is provided on the flange. The casing is of cast iron and slopes downward toward the forward end, where an oil drain plug is provided. The simple provisions made for preventing leakage of lubricant through the end bearings of the box are of interest. The shaft on which the clutch pedal and the clutch shifter lever are mounted has a bearing in the bell housing flange.

Mechanics Model J Transmission

IN the Model J transmission, which was placed in production by the Mechanics Machine Co. of Rockford, Ill., toward the end of May, the concern follows its past practice in making a standard gearbox that can be fitted to bell housings of different designs and sizes. It has been found that this practice not only is equally economical from a manufacturing standpoint but lends itself much better to various installation requirements that must be met by the parts maker.

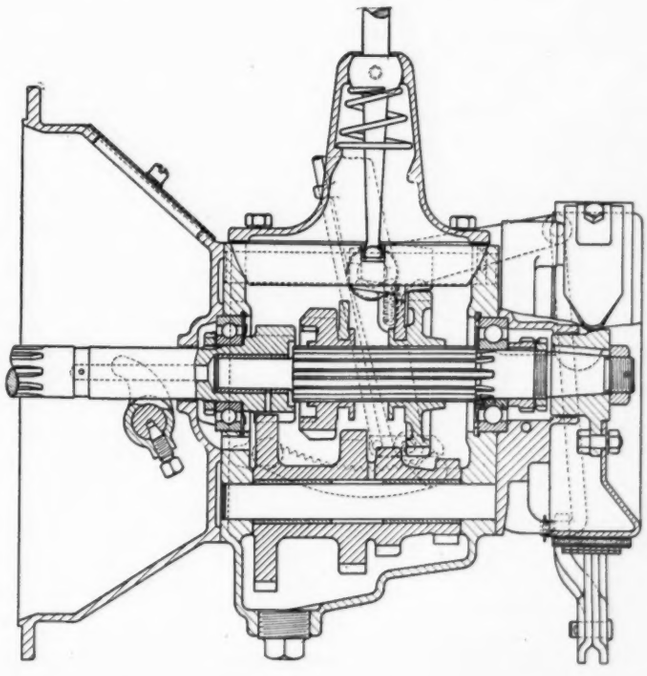
In the design illustrated the gearbox proper is assembled with a bell housing that is to take a push-type clutch, which type, the manufacturers say, seems to be coming into favor quite rapidly. However, bell housings for the pull type of clutch can also be supplied.

The gearbox is secured to the bell housing by four ½-in. S. A. E. cap screws, which can be reached from the outside of the transmission. A departure from the previous practice of the company has been made in mounting the gearshifter rods in the gear case proper instead of on the cover. This construction, it is claimed, reduces the possible error in the mesh of the gears and it also allows the holes for the shifter rods to be drilled and reamed at the same time that other work is being done on the case which reduces the cost of machining.

The gears are made of alloy steel and heat-treated. In this connection it is of interest to observe that the Mechanics Machine Co. makes its own drop forgings and also does its own heat-treating.

The direct drive clutch is of the internal gear type with full involute teeth which mesh with the teeth of the driving gear. No end thrust can be transferred from the drive shaft to the splined shaft, as the former is located endwise by the forward ball bearing and the latter by the rear ball bearing.

This transmission is designed for use on engines developing up to 120 lb-ft. torque.



Automotive Industry Accepts Balloon Tires—with Many Reservations

Even producers admit that they introduce problems. Four-ply type favored. Many see need for wider rims and are disposed to give drop base variety careful consideration. 20 in. diameter most popular. Others advocate 21 and 22 in.

By Herbert Chase

A CANVASS of the automotive industry, including about thirty prominent automobile manufacturers and several of the largest producers of wheels and tires, indicates that a goodly majority believe that balloon tires are a thoroughly practical commercial development worthy of general adoption.

This does not mean, of course, that such tires are free from faults. In fact, a number of difficulties such as side wall failure, side roll, shimmy, harder steering and excessive noise have been pointed out, but few regard these faults as being insuperable.

A large majority favors four-ply rather than six-ply construction, but there is considerable diversity of opinion as to the most desirable inflation pressure. Pressures varying from 15 to 40 lb. per sq. in. are considered desirable by different users.

There is a disposition on the part of most of those who answered the questionnaire to regard present "standard" rims as being satisfactory, but some who have investigated the matter carefully, including three out of five large tire makers are certain that present rims are not wide enough to give adequate lateral stability and prevent side roll.

Drop Rim Base Experiments Favorable

A considerable proportion of those who have investigated drop base rims are inclined to favor their adoption, but there is an apparent lack of information based on experience and some have given it little if any consideration. It is recognized also that a change to this form of rim would involve various manufacturing and service complications, although some believe that the advantages are well worth the difficulties involved in departing from conventional practice.

A majority favors rims of 20-in. base diameter, but there are strong advocates of the 21- and 22-in. diameter type, especially for tires of the smaller sections. These sizes are demanded largely because a smaller diameter gives inadequate road clearance and in some instances interferes with brake mechanism. Use of three diameters is deprecated, especially by tire companies, but they recognize the difficulties involved in the general adoption of a single diameter.

Aside from changes which may be necessary to give adequate clearance and reasonably easy steering, the chief changes in car design which are expected to result from balloon tires are those involving spring suspension. It is recognized that balloon tires may lead to lighter running gear and chassis parts or to greater life if the present weight of parts is maintained. Some even think that both lighter weight and increased life of car are possible results of balloon tire construction.

This brief summary of opinion on various points covered by the questionnaire does not, of course, tell the whole story. Many of the individuals who reply do not agree with the majority and appear to have good grounds for the position they take. Furthermore, many points are raised which have an important bearing on the subject, but which a general summary, in the very nature of things, cannot give.

Good Grounds for Dissenting Opinions

It is evident also that the company connection of the individual making a reply are highly significant, because, if connected with a large producer and his views reflect those of the company they may have a more important bearing upon the final outcome of the matter than those of a representative of a smaller producer.

For these and other reasons we are giving in following pages a consensus of opinion expressed in the replies to each question together with a number of quotations from replies which go into details of importance. In some cases the name of company and individual is omitted because of requests that this be done.

The first question was:

Do you regard balloon tires as a thoroughly practical commercial development worthy of general adoption?

Replies are about 75 per cent in the affirmative, 20 per cent negative and the remainder uncertain. Negative replies came from Locomobile, Paige and Willys-Overland engineers, among others, and many in both the negative and affirmative are qualified.

In this connection Henry M. Crane of the General Motors Corp. says: "There is no doubt that some form of low pressure tire is going to be a practical commercial development, but I do not know what ones of the twenty-three standard varieties you have in mind. It all comes from the fact that this particular development is in a partly finished condition and the tests very incomplete."

Another prominent engineer connected with a large car producer replies to this question as follows:

"We believe that the balloon tire is fundamentally right, but there is not, to our knowledge, a balloon tire equipped car today that performs in a satisfactory manner or in a manner that would make the balloon tire last if the disadvantages could not be overcome."

What One Wheel Manufacturer Thinks

C. C. Carlton, secretary of the Motor Wheel Corp., has this to say: "There is no question in our opinion but what the balloon tire is here to stay; that it is the finest improvement on riding qualities for an automobile that has ever been made. The balloon tire is at the present time a proved success and when I say "balloon tire" I

refer to the small diameters, particularly the 20-in. and include the 21-in., and refer entirely to a four-ply tire.

"We have more than twenty automobiles in our garage here that have been equipped with balloon tires, all 20 in. diameter, for more than one year. We have accumulated tire mileage running as high as 24,000 miles on one set of tires and we have several cars that have passed 15,000 miles. I mention these things merely to emphasize the statement that we believe the balloon tire is an established success at the present time."

J. M. Crawford, Chief Engineer, Auburn Automobile Co., states that "we are finding an increasing demand for balloon tire equipment and are now shipping practically 50 per cent of our cars with this equipment."

The second question was:

What are their (balloon tires') weakest points?

Responses to this query indicate that these tires still are a long way from perfection, although one of the faults most prominently mentioned, namely, the tendency to shimmy is, in the opinion of some engineers, due more often to some fault in the chassis than to the tires.

Over 40 per cent of the replies received mention shimmying or galloping as among the weak points of the tire. By galloping is meant a tendency to bounce at certain speeds, probably in synchronism with the natural period or some harmonic of the period of the spring. In any case, this fault has been eliminated or minimized in some instances by applying stiffer springs and some form of the many different types of shock absorbers which have been devised.

Hard steering is mentioned in twelve replies and undoubtedly is one of the chief faults of balloon tires. Three mention side roll, presumably due to lack of lateral stability. This fault is attributed by some to the use of a rim which is too narrow and is said to be rendered negligible by use of a rim which is wide enough to give the same angle of stability that has proved satisfactory with high pressure tires.

Two correspondents mention side wall failure as among the faults of balloon tires. Each of the following faults are cited in one reply: treads too thin, difficulty of maintaining correct inflation pressure, short life, cramping of chassis design, dust raising, excessive noise, dangerous at high speed, possible throwing at high speed, tendency to ruin tube when punctured, narrow rims damage casings, and tendency to go to extremes of size and thickness.

Six replies, however, say in effect that balloon tires are without faults and one complains chiefly of the inability of the makers to furnish a sufficient supply to car manufacturers.

Some typical and some especially informative replies are quoted below:

One maker of a large car in the high price class says, "So-called 7.30 tires on narrow rim widths, judging from our experience with them, are not at all satisfactory for general use. They are a slow-speed device, being, on account of their galloping and shimmying tendencies positively dangerous at speeds above 45 m.p.h. and are very undesirable at low speeds due to hard steering. The future of this size tire will depend entirely on the tire and automobile engineers' ability to work out a tire and rim combination, that will make the performance satisfactory throughout the speed range. Unsatisfactory performance at speed, such as shimmying galloping and wandering, has not been overcome in the full balloon, but can be overcome in semi-balloon tires by air pressures used."

S. P. Thatcher, Technical Director of the United States Rubber Co., gives it as his opinion that "the main difficulty likely to be encountered is in the misapplication of the tire to existing cars. Unless the proper size tire, mounted on the proper size of rim and used on wheels giving the necessary clearance between fenders, frames, steering rods and brake toggles is used, and unless proper inflation pressures are maintained the motorist will not obtain from the balloon tire that degree of satisfaction which he has been led to expect."

An engineer of one large car manufacturing concern whose experience with balloon tires is quite unsatisfactory, says:

"One disadvantage is the very loud grating noise caused by the vibration set up by the non-skid treads and by various kinds of brick pavements. This vibration is transmitted to the tire carcass which acts as a diaphragm and which magnifies the noise to an extremely objectionable point. This difficulty has become apparent with the increasing tendency to employ lower air pressure even on the present type of high pressure tires, due to the fact that the tread approaches the road bed or pavement at a more acute angle if the tire is partially deflated.

"The present tendency of using smaller wheels also has aggravated this condition very much. The only partial remedy we know is to use ribbed tread tires and this will hardly be an acceptable solution inasmuch as the public has been educated to the use of all-weather treads.

"Ribbed treads do not affect the noise of the tire on brick pavement inasmuch as the vibration is transmitted from the road surface to the carcass, in this case. As stated, the balloon tire is the noisiest type of tire that has been developed and the so-called "silent treads" turned out by a number of manufacturers are practically no improvement over the original all-weather treads.

"The second difficulty is that the tire itself has a period which will cause great discomfort if this tire period has a simple relation to the period of the springs. Snubbers are recommended by several tire manufacturers, but snubbers will defeat the main purpose of the balloon tires, that is, they will greatly impair the riding of the car on cobble stone pavements.

"Front wheel brakes have necessitated center point steering with an inclined steering pivot. This inclined steering pivot causes considerably harder steering than the vertical type formerly used, and it has been necessary in order to make the steering easier, especially where balloon tires are used, to employ antifriction bearings in the steering knuckles to compensate for this.

"We do not think it possible to balance a wheel equipped with a brake drum so closely that the centrifugal force does not tend to produce the so-called "shimmy." As this tendency recurs at various speeds on

THIRTY engineers connected with as many prominent automobile manufacturers, five tire engineers, representing the largest makers in this country and England and two engineers with big wheel producers answered AUTOMOTIVE INDUSTRIES' questionnaire concerning balloon tires and rim equipment intended for their use.
Their replies are summarized in this article which we believe gives the best picture of the balloon tire situation which yet has appeared in print.

smooth pavements we are certain this is caused by centrifugal force. With the high pressure formerly employed the centrifugal force was absorbed twice during a revolution due to the fact that the unbalance could not cause the hard tire to deflect downward, nor would it tend to raise the wheel upward when the unbalance was directed down and up respectively.

"With balloon tires, however, this unbalance has an action on the wheel through the entire revolution, and, aided by the anti-friction bearings in the knuckle pivot, the 'shimmying' tendency occurs at a tremendous rate and at relatively high speeds. There are ways to overcome this tendency, but the standard type of axle equipped with front-wheel brakes is, in our opinion, doomed for a thorough re-design before the balloon tires can be applied with entirely practical results.

Principle of the Pendulum

"It is a well known fact that a heavy pendulum can be made to swing by a very weak escapement mechanism. The pendulum in this case is the heavy front wheels and the escapement mechanism the unavoidable unbalance due to manufacturing errors in the tire carcass as well as the wheel itself.

"The fourth difficulty is the tendency of a car equipped with four-wheel brakes to pull to one side, due to the variation in the tire inflation pressure. This is rather serious as a difference of 5 lb. pressure seems to produce these results."

In your opinion are any of these faults (as specified in the foregoing question) serious or insuperable?

This was the third question asked. A little more than half the replies were categorical noes. The five who consider the balloon tire practically faultless, of course, had no occasion to reply to this question. Of the remainder, five consider the faults serious but not insuperable. One replies "yes" without qualification, one says "yes in present design" and one says the faults will be corrected.

While admitting readily that balloon tires have some faults, only one of the replies from tire makers indicates that the faults are regarded by them as being serious.

Next in order on our questionnaire is the query:

Do you prefer four or six-ply construction?

Response in this connection shows a "vote" of about four to one in favor of the four-ply casing, but there are some qualifications, such as the following: four-ply, but good results with six; four-ply, if they stand up; experiments limited to four-ply; probably four-ply, but am not sure; six-ply is "not true balloon"; six-ply "just half way compromise"; have not tried six-ply; four and three-ply. Two replies frankly express uncertainty on this point.

Tire Manufacturers Do Not Agree

Tire manufacturers undoubtedly are best qualified to express opinions in this regard, but they do not entirely agree among themselves. Some views of prominent tire makers are given in the following paragraphs:

Colin Macbeth of the (British) Dunlop Co. says, "Four heavy plies on big tires, four light plies on small tires, same factor of safety on all.

Goodrich prefers four-ply construction in most cases.

Firestone says four-ply Goodyear indicates that the number of plies is dependent on the load which the tire is to carry, while United States gives an excellent summary of the situation in the following words:

"We have used three, four and six-ply constructions (depending upon the sectional size of the tire) and some manufacturers have made two-ply tires. Keeping in mind that the basis for the design of a tire section is the weight to be carried and the inflation pressure desired, the opportunities for variation in cord construction, size and spacing that are now available to the tire manufacturer make possible a four-ply tire equal in performance to a six-ply tire, each containing approximately the same weight of cotton. As the technique of tire design becomes more widely known less attention will be given to the number of plies."

What About Punctures?

In respect to the relative liability to puncture of balloon and high pressure tires our questionnaire propounded the following question:

Are punctures more frequent than with high pressure tires if correct inflation pressures are used?

Weight of opinion and experience on this point indicate that punctures are not more frequent with balloon tires. Unqualified answers are in the ratio of about eight negative to five affirmative and six say punctures are less frequent with balloon tires. Qualified replies run all the way from "no less liability" to "yes, with four-ply."

Strictly comparable and convincing evidence in a matter of this kind is difficult to secure except through compilation of experience with a great number of cars carrying the respective types of equipment in question over a long period of time.

A thinner wall and tread and a greater area of contact with the road are the chief items which might be expected to increase punctures. To offset these, however, is a considerably lower unit pressure between tire and road—a drop from 80 to 45 lb. per sq. in., according to Mr. Macbeth of the Dunlop Co.—which, of course, greatly decreases the force tending to force sharp objects through the tire wall. Mr. Thatcher points out also that many high pressure tires have as thin walls as do balloons.

Pressure and the Number of Fabric Plies

Questions six and seven read as follows:

6—What inflation pressure have you found most suitable?

7—To what size of tire, load and number of ply tires does your answer to question No. 6 apply?

Answers indicate that there is a great difference of opinion as to the best inflation pressure, even for a given size of tire and load. The number of plies of fabric, of course, also have a bearing on this point. An approximate average of the figures mentioned, however, is 28 lb. per sq. in. But since the limiting figures are 15 on the low end of the scale and 42 on the high end an average figure is not of much significance. A record of practice followed by individual concerns is given in the accompanying table.

The chief engineer of one prominent maker of high grade cars says: "At present we favor an intermediate balloon program. For anyone who wants this type of tire equipment we consider the 33 x 6.60, as far as performance is concerned, a fairly satisfactory tire and recommend 35 lb. as the minimum pressure for moderate speeds and loads but when speed and heavier loads are encountered higher pressure should be used. Likewise we recommend a wider rim than that specified by the tire companies, it being our experience that a 6 in. tire mounted on a 6 in. rim, actual width of which is 4.33 in., is more satisfactory on the road from a standpoint of wheel gallop than when mounted on a 5 in. rim, actual width 3.75 in."

Henry M. Crane is of the opinion that inflation pressure "undoubtedly will have to be worked out for each

particular case, as it is not only a question of tire durability but also a question of the relation between the spring of the tire, the vehicle spring, the axle weight and the vehicle weight."

Another engineer expresses the view: "In reference to the inflation pressure, tire size, load and number of plies, we think that the question is merely one of comfort standards. Certain tire manufacturers have arbitrarily adopted a certain comfort standard requiring very low air pressures and have designed tires accordingly. It is, however, evident that the lower the air pressure is, the worse the disadvantages are, and the higher the pressures are the smaller is the improvement in riding comfort."

Inflation Pressure Remains to Be Settled

It is apparent from the foregoing that the matter of inflation pressure is yet to be settled and is dependent upon a number of inter-related factors. The Rubber Association of America has made the recommendation that manufacturers adopt inflation pressure tables based upon a deflection under load of 22 per cent of the sectional diameter of the tire. That this course is being followed by at least one of the large tire makers is evidenced by the following reply from P. S. Thatcher of the United States Rubber Co.:

"The following load and inflation table is the one we have recommended and it is based on a tire deflection of 22 per cent regardless of the number of plies in the various sizes. This is because our tires, whatever their carcass construction may be, possess the necessary flexibility."

	Tire Section Sizes, in.						
Inflation pressures Lb. per Sq. In.	4.40	4.95	5.25	5.77	6.20	6.60	7.30
	Load on Tire, lb.						
20	550	645	700	810	900	990	1150
22	590	700	760	880	980	1080	1260
24	630	755	820	950	1060	1175	1370
26	670	805	880	1020	1140	1265	1480
28	710	860	940	1095	1220	1355	1590
30	*750	910	*1000	1165	*1300	1445	*1700
32	790	965	1060	1235	1380	1535	1810
34	830	*1020	1120	*1305	1460	1625	1920
36	...	1075	....	1375	....	*1715	....
38	...	1145	....	1445	....	1805	....
40	...	1210	....	1515	....	1890	....

*Highest loads recommended for each size.

In using the above table for figuring wheel weights use the following passenger loads:

Roadsters and coupes	Figure 2 passengers
Five-passenger phaeton	Figure 3 passengers
Five-passenger sedan	Figure 3 passengers
Seven-passenger phaeton	Figure 4 passengers
Seven-passenger sedan	Figure 4 passengers

Question No. 8 was:

What rim diameter do you prefer and why?

Replies make it quite apparent that there is a decided leaning toward the 20 in. size, although a considerable number favor the 21 in. and some use both 20 and 21. Furthermore, some large producers among the car manufacturers favor the 22 in. rim, hence it seems likely that all three rim diameters will continue in use for some time to come.

Rim Diameter Depends on Road Clearance

H. M. Crane states that the rim diameter "depends almost entirely on desirable road clearance. The General Motors Corp. has taken a definite stand in favor of the 22 in. center on the smaller sizes and the 21 in. center on the large size."

Aside from the matter of adequate ground clearance, brake and fender clearances, however, there is little opposition to 20 in. rims, for the reason that there is a general desire to keep cars as low as possible. It appears likely that when an entirely new chassis is being designed it will be possible to make a layout that will give adequate clearance and still use 20 in. rims. Most objections to this size, we gather, result from difficulties encountered in fitting small diameter rims to existing chassis. In any case, the standing diameter of balloon tires on 20 in. rims is not greatly different from that of most equivalent high pressure sizes.

It is worthy of note that a small rim diameter reduces the weight of the rim itself as well as that of the wheel and the tire, a fact which should make a corresponding difference in cost. In this connection Geo. P. Dorris, president of the Dorris Motor Car Co., gives us the following information:

"A change from wood wheels with 32 x 4½ in. Firestone rims, to wire wheels with 20 x 4½ in. rims on which are mounted 32 x 6 in. semi-balloon tires reduces the weight per wheel 23 lb., and when you consider the elimination of this weight per wheel the gain can be counted three times, first, it is less overall load; second, it is less unsprung load; third, less weight to accelerate and decelerate at the rate the wheel rims travel. Altogether, the advantage is very favorable."

Of importance equal to or greater than rim diameter is rim width. There is considerable diversity of opinion on this subject as indicated by replies to questions numbered 9 and 10 which read as follows:

9—Are present standard rim widths satisfactory?

10—If not, why not?

Categorical replies to No. 10 stand in the ratio of about 8 to 3 in the affirmative, but among the negative responses are three prominent tire manufacturers, Goodrich, Goodyear and (British) Dunlop, and a number of large car producers including Chrysler and Gardner. Other replies are qualified or less emphatic, such as: we think so; evidently; prefer wider ones; yes, with medium sizes; on narrow side; etc.

Among those who consider present rims too narrow are a number of concerns who have been giving the matter close study and have found decided advantages in the wider rims. It is admitted that they are somewhat heavier, but the greater lateral stability, that is, comparative freedom from side roll, is said to make for greater safety and comfort.

We quote below some opinions on this subject, omitting the source of the information where requested to do so:

Colin Macbeth gives it as his opinion that the only point now lacking to bring the balloon tire in as standard equipment is the general adoption of a correct ratio of rim width to tire section and considers it "deplorable

ARE you familiar with the drop base rim?

If not, it will pay you to get acquainted. Many prominent concerns who manufacture passenger cars and tires are experimenting with it and have been favorably impressed by its qualities.

It appears to possess many advantages, especially for the user, who, of course, is the one all manufacturers should seek to please in last analysis.

Number of Question Asked	1	3	4	5	6	7
Question Asked	Do you regard balloon tires a thoroughly practical commercial development worthy of general adoption?	Are any balloon tire faults insuperable or serious?	Do you prefer four- or six-ply construction?	Are punctures more frequent than with high pressure tires if correct inflation pressures are used?	What inflation pressure have you found most suitable?	To what size of tire, load and number of plies does your answer to preceding question apply?
Name of Individual Who Replied and His Company Connection						
C. A. D., Chief Engineer, Anderson Motor Co.	Yes	No	Six	No	20 to 25 lb. per sq. in.	6.20—3600 to 4000 lb.
Auburn Automobile Co.	Yes		Not tried six-ply	Probably not	28 to 30 lb.	5.25/21—750 to 800 lb.
C. N. Thompson, Ass't. Ch. Engr., Chandler Motor Car Co.	Yes	No	Four	Less	30 lb.	6.20/21—4-ply
Cleveland Automobile Co.	Yes	No	Four	No	30 lb.	31/5.25—2700-3100 lbs.
G. P. Dorris, President Dorris Motor Car Co.	Yes	No	Six	No difference experienced	30-40 lb.	32/6—4000 lb.
J. Rawley, Chief Draftsman, Dort Motor Car Co.	Yes	No	Four-ply if they stand up	No, less liability	25-26 lb.	31/5.25—2800-3000 lb. 4-ply
F. S. Duesenberg, Chief Engineer, Duesenberg Automobile & Motors Co.	Yes	No	Don't know	Don't know	26-30 lb.	7.30/34
W. F. Pfander, Chief Engineer, Durant Motors, Inc.	Uncertain			Not found more frequent	Varies as much as high pressure tires	
M. H. Blank, Works Manager, Elgin Motors, Inc.	Yes	No	Four	Evidently not	23 front; 30 rear	6.20/20—3250—4-ply
L. M. Stellmann, Chief Engineer, H. H. Franklin, Mfg. Co.	Yes	No	Four	Less	25 front; 30 rear	5.25/31—4-ply—Sedan
The Gardner Motor Co.	Yes		Four	No so far	20 to 40 lbs. depends on load	5.25 4-ply
Henry M. Crane, Tech. Asst. to Pres., General Motors Corp.	?				See text	
W. D. Collins, Assistant Engineer, H. C. S. Motor Car Co.	Yes		Four	No	30 lb.	32/6.20—4-ply
F. E. Watts, Chief Engineer, Hupp Motor Car Co.	Yes	?	?	Yes	Varies with service	
E. G. Gunn, Chief Engineer, LaFayette Motors Co.	Yes		Four	No	About 28 lb.	34/7.30 — 4-ply; 1150 lb rear; 1000 lb. front
Delmar G. Roos, Vice-Pres., Locomobile Co. of America	No	Yes	Six	Yes	32 lb.	34/7.30—4- or 6-ply
B. Jerome, Chief Engineer, Oakland Motor Car Co.	Yes	No	Four	No	25-35 lb.	4-ply
R. K. Jack, Chief Engineer, Olds Motor Works	Yes	Serious but not insuperable	Four	No difference noticed	30-35 lb.	4.95—1000 lb. 4-ply
Paige Detroit Motor Car Co.	No	Yes—serious	Probably four	Probably — not sure	33 lb.	6.60/21—4-ply—1200 lb.
Chas. B. Shanks, The Rollin Motors Co.	Yes	No		Less liable to puncture	25 lb.	5.25
Other Passenger Car Manufacturers Names Withheld by Request	No	Too serious for production. Not insuperable	Six	Yes	35 lb. up	33/6.60—6-ply—1300 lb.
	Yes	No	Four-ply but good results with six	Difference unimportant	Tire makers' recommendation	Any size—4-ply
	Yes	No	Four and three	Not in our experience	25-30 lb.	5.25/21—2400 lb. 3-ply
	Yes	No	Four	Don't think so	Follow tire makers' recommendations	32/6.20
	Yes, in one year	No	Four	Not as many	30 lb.	22/5.77—4-ply—1000 lb.
	Yes	Serious	Four	No	As recommended by Firestone	
	No	No	Experience limited to four-ply		20-25 found satisfactory	5.25/21—4-ply 2000 to 20 lb.; 6.20/20—4½ in. ply—3150 to 3400 lb.
	No	No	Six	Yes, with 4-ply	Higher than recommended	6.20/20—4-ply
Colin Macbeth, Experimental Engr., Dunlop Rubber Co., L't'd.	Yes	No	Four heavy, big tires; four light, small tires	No. Less frequently	15 to 25 lb. according to size	4½ in. 15 lb., 5 in. 17 lb. in., 20 lb., 7 in. 25 lb. all 4-ply
J. E. Hale, Mgr. Development Dep't, Firestone Tire & Rubber Co.	Yes	No	Four	No	Select size to enable 25 to 30 lb.	Not over 35 lb. or deflecti of 21% of section diame
The B. F. Goodrich Co.	Yes		Four-ply most cases	No	Depends on size and weight should not exceed 38 to 42	
P. W. Litchfield, 1st Vice-Pres., Goodyear Tire & Rubber Co.	Yes	Serious, yes	Depends on load carried	Yes	Varies with size and load	
S. P. Thatcher, Technical Director, United States Rubber Co.	Yes	Will be corrected	See text	Not much if any	See Table II	
C. C. Carlton, Secretary, Motor Wheel Corp.	Yes	No	Four	No	20-30 lb. depends on car weight	
H. A. House, Jr., Chief Engineer, Wire Wheel Corp. of America	Yes	No	Four	Do not puncture as readily	About 20 lb.	6.75/20—3460 lb.—4-pl

8 What rim diameters do you prefer, and why?	9 Are present standard rim widths satisfactory?	11 Do you favor the drop base rim?	12 Have you experimented with drop base rims?	16 Do you expect balloon tires to result ultimately in a considerably lighter and more flexible car construction?	..... Number of Question Asked ..... Question Asked Name of Individual Who Replied and His Company Connection
28x4 in.	Yes	Yes	Yes	No	C. A. D., Chief Engineer, Anderson Motor Co.
20 and 21 in.	Yes	?	No	Y	Auburn Automobile Co.
20 in., if sufficient road clearance	Yes	No opinion yet	No	No	C. N. Thompson, Ass't. Ch. Engr., Chandler Motor Car Co.
21 for clearance; 20 in. looks better	Yes	Can't answer	No	Not considerably	Cleveland Automobile Co.
20 in. in place 33x5 and 33x4½	Yes. 4½ for 32x6	No experience	No	5 to 10% weight reduction	G. P. Dorris, President Dorris Motor Car Co.
21 in. for clearance	Yes		No	No	J. Rawley, Chief Draftsman, Dort Motor Car Co.
20 in.	Prefer wider rim	Don't know	On racing cars	Yes	F. S. Duesenberg, Chief Engineer, Duesenberg Automobile & Motors Co.
20 in.	Using tire men's specifications				W. F. Pfander, Chief Engineer, Durant Motors, Inc.
20 in. for smaller wheel	Evidently	Not familiar	No	No	M. H. Blank, Works Manager, Elgin Motors, Inc.
Prefer 21. Would prefer 22 if made	Yes	May have advantages	Very little	Favor light flexible car if built to stand up	L. M. Stellmann, Chief Engineer, H. H. Franklin, Mfg. Co.
	No				The Gardner Motor Co.
22 in. smaller sizes; 21 in. larger sizes	Know nothing against them	Like some features	Not personally. Company has		Henry M. Crane, Tech. Asst. to Pres., General Motors Corp.
20 in.	Yes		No	No	W. D. Collins, Assistant Engineer, H. C. S. Motor Car Co.
Maintain present o.d. and road clearance	Yes		No	No	F. E. Watts, Chief Engineer, Hupp Motor Car Co.
Experimented with 20 in.	Yes		It looks good	No	E. G. Gunn, Chief Engineer, LaFayette Motors Co.
Can use only 20 in.; would prefer 22—6- or 7-ply	Yes	No	No		Delmar G. Roos, Vice-Pres., Locomobile Co. of America
20/3½; no change road clearance or gear ratio	Yes	Looks interesting	No	No	B. Jerome, Chief Engineer, Oakland Motor Car Co.
22 in. to maintain ground clearance	Yes, with medium size balloons	No		No	R. K. Jack, Chief Engineer, Olds Motor Works
21 better appearance; more clearance than 20	Prefer 4½- or 5-in. for 6.60 tire		No	No	Paige Detroit Motor Car Co.
	Yes			Yes	Chas. B. Shanks, The Rollin Motors Co.
21 in. to get clearance	No	Quite interesting	Yes	No	Other Passenger Car Manufacturers Names Withheld by Request
20 in.	No	Yes	Yes	Not necessarily	
21 in.—20 too little clearance—22 in. looks like standard tire	On narrow side		No	No	
20x4½ suits our car best	We think so	No	No	Hope for lighter construction	
21 in. for adequate ground clearance	Yes	No	Yes	Yes	
21 for 5.25, 20 or 21 for 6.20, 20 for 7.30, least change in clearance	4 in. for 5.25, 4½ or 5 for 6.20, 5 in. for 7.30 are satisfactory	Good mechanical construction	No	No	
21 in. satisfactory	Thus far. Advantages in interchangeable parts	Some advantages	Yes	No	
	Yes, if very low pressure is not used	No information	No	No	
21 in. because standing diams. remain satisfactory	No—too narrow	Yes	Always used it for full balloons	Yes, all units lighter	Colin Macbeth, Experimental Engr., Dunlop Rubber Co., L't'd.
20 and 21 in. necessary to give no increase in standing diam.	Narrow rims logical and give entire satisfaction	Not necessarily opposed. Weight reduction and satisfaction not proved	Are experimenting	Yes	J. E. Hale, Mgr. Development Dep't, Firestone Tire & Rubber Co.
21 and 22. Car should be low. Large diameter tires expensive	No	Yes	Yes	Yes	The B. F. Goodrich Co.
21 in. only diam. logical for complete standardization without radical car design	No	No	Yes	Yes	P. W. Litchfield, 1st Vice-Pres., Goodyear Tire & Rubber Co.
No preference. Numerous sizes rettable	No standard. Present widths satisfactory See text	Many good features. Adoption difficult	Yes and still are experimenting	Yes	S. P. Thatcher, Technical Director, United States Rubber Co.
20½ for 4.40/21, 29x4 for 5.75/21, 29x4 for 5.25/20, 29x4½ for 6.20/20, 30x4½ for 6.20/21, 30x5 for 7.70/20 and 31x5 for 6.20/21	Yes	No	Very little	Possibly some but not considerably	C. C. Carlton, Secretary, Motor Wheel Corp.
21 in. for adequate clearance	Yes, if not oversized	Yes	Yes. Have a set of 32x6 in. Dunlop rims	Yes	H. A. House, Jr., Chief Engineer, Wire Wheel Corp. of America

that narrow rims should ever have been allowed to get such a hold as is the case today." He believes that the rim width should be 66 per cent of the tire section as with giant pneumatics and airplane tires.

One prominent engineer connected with a large American producer of high grade cars, who says he has been considering the subject thoroughly, expresses the view that the nature of the rim equipment has little if anything to do with shimmying except that the greater weight of the wider rim makes it worse rather than better.

In contrast to this another engineer who holds a similar position with another large concern making a car of about the same size and price recommends a wider rim than that generally specified by the tire companies. In his experience a 6.60 in. tire mounted on a 6 in. nominal size rim, actual width 4.33 in. "is more satisfactory on the road from a standpoint of wheel gallop" than when mounted on a 5 in. nominal size rim having an actual width of 3.75 in. He adds that "Dunlop drop base tires mounted on wide rims seem to offer a possible solution, but will require considerable experimenting before approval can be given them."

Rim Widths

S. P. Thatcher gives us the following information:

"There is apparently no standard practice with respect to rim width. For example, the 32 x 6.20 in. tire is being used on both 28 x 4 and 29 x 4½ in. rims and is operating satisfactorily in both instances. The progressive development of the balloon tire may in time result in wider rims. At present, however, we believe that the rim widths in use with the present line of tires are satisfactory."

J. E. Hale of the Firestone Tire & Rubber Co. makes this reply:

"While there is a standard written into the Tire and Rim Association records, the automobile manufacturers have chosen rim widths which cover all extremes. Narrow rims save some weight and money, consequently we believe they are the logical ones to use. Also we know positively that tires will give entire satisfaction when used on narrow rims."

Readers who desire further details on the subject and theory which underlies rim width in relation to tire dimensions are referred to articles by Colin Macbeth which appeared in AUTOMOTIVE INDUSTRIES for Nov. 8, 1923, p. 949 and Dec. 20, 1923, p. 1267. These articles give also important information regarding the drop base rim advocated by Mr. Macbeth and dealt with in the following questions, Nos. 11 to 14 inclusive.

Drop Base Rims

Questions numbered 11 to 14 read as follows:

11—Do you favor the drop base rim?
12—Have you experimented with it?
13—If so, with what results?
14—Do you expect it will be adopted generally for American passenger cars and why, or why not?

Replies indicate that this type of rim is not so widely known as it should be in view of the apparent merits which it possesses.

Drop base rims are not new. They have been popular on European bicycles for many years and are used widely on airplane wheels. Their chief disadavantage appears to be a possibility that the tire may come off the rim if the tire is deflated when the wheel is turning. This possibility is said to be precluded by use of a special catch bead advocated by Dunlop. Such a bead is claimed also to protect the tire and tube against damage if run deflated, but it necessitates a modified mold equipment for production.

Advantages claimed for the drop base rim include: lighter weight and lower cost, one-piece construction, facilitates using a valve placed at an angle to the plane of the wheel and which can be made standard for all sizes of tubes, not easily damaged and, perhaps most important, ease of changing tire. It is claimed that this can be done without the aid of tools.

Those who replied without qualification to question No. 11 are about equally divided between "yes" and "no." Nearly all others, however, are either favorably inclined or not fully informed, while several of those not in favor of the drop base type say they have not experimented with it.

Companies Which Are Interested

Three large tire companies favor the drop base rim and the same is true of one important American wheel manufacturer who is understood already to be manufacturing this type of wheel. Others who are much interested include the General Motors, Chrysler and Anderson companies.

The attitude of the Firestone Tire & Rubber Co. as reflected in the reply of J. E. Hale, is as follows:

"We are not necessarily opposed to the drop center rim. However, no weight reduction or lower cost advantages have been demonstrated in comparison with present American rim practice. Furthermore, we do not believe anybody has run these rims enough millions of miles to know positively whether they will be satisfactory mounting for tires."

Nearly two-thirds of those who replied to question No. 12 indicate that they have not experimented with the drop base rim. Those who have done so give replies such as: "easy to change tire"; "looks meritorious"; "entirely satisfactory"; "splendid results from start"; "good" and "fair results, needs further tests," to question No. 13. There are, in fact, but two unfavorable replies to this question and they cite possibility of punctured tubes in changing and trouble due to premature failure of side walls because of gravel getting under the safety bead.

Difficulties Stand in the Way of Adoption

Comments made by S. P. Thatcher of the United States Rubber Co. give a good idea of the attitude of some tire interests on this subject:

"There are many features about the drop base rim to recommend it. Its adoption, however, would be rather difficult owing to the probability that balloon tires now considered standard could not be used on it.

"Results of tests indicate that a special type of tire is needed for it and that in order to permit easy mounting and dismounting of tires the present widths of rim are too narrow."

Colin Macbeth says that the (British) Dunlop Co. has had "splendid results from the very beginning and have been unable to pull a tire off the rim even when intentionally burst at high speeds. Tires with drop base rim of big sizes can be fitted by hand. Use of this rim brings about: reduction in weight, increase in strength, absolute simplicity, reduced cost, better accommodation of front wheel brakes, due to no interference by valve at an angle, and standardization of valve length, all of which greatly help and in some cases are made possible only by the drop base rim."

When it comes to views concerning the general adoption of drop base rims for American passenger cars, referred to in question 14, the manufacturing and service considerations involved in a change from conventional

practice of necessity come prominently to the front. This is evidenced by a reply from H. M. Crane, who says that he likes very much certain features of the drop base rim, such as its light weight, appearance and ease of handling, but points out that "the drop base rim would probably have to be very much better or cheaper to force itself in as a standard."

Anderson and Gardner engineers say definitely that they expect the general adoption of the drop base rim, but there are others who disagree on this point.

Among the tire companies also opinions in reference to adoption of the rim differ. Dunlop considers it likely to come because it seems logical, Goodrich considers it too early to say, though favorable to the drop base type, Goodyear replies negatively though also favoring the rim, while United States and Firestone are not ready to express an opinion. Practically all replies unfortunately appear to leave the user out of the picture.

Comfort the Main Consideration

On this point Mr. Macbeth reasons as follows: "We must realize that from the users' point of view and the manufacturers' point of view, comfort is the main consideration under all conditions. The narrow rim does not give this, whereas the wide rim will give comfort and then the manufacturers will begin to look for ease of fitting, weight reduction, cost reduction and simplification. When they do this it will bring the drop base rim into its own."

An engineer with one large car producer points out that the public is used to bolted on demountable rims. For this reason he doubts whether drop base rims, which, he says, do not lend themselves to this type of construction will come into general use, at least for some time.

Question 15 reads:

Aside from changes to give adequate clearance and reasonably easy steering, what, if any, changes in car design do you expect to result from the use of balloon tires?

Prominent mention in replies is given to revisions in spring design and possible savings in weight. About a third of the replies refer to springs or shock absorbers. Shorter, stiffer or less flexible springs are indicated when spring qualities are mentioned and one reply even suggests that springs may be eliminated on small cars.

Duesenberg Likes Balloons

In this connection F. S. Duesenberg of the Duesenberg Automobile & Motors Co. says:

"I am very much in favor of balloon tires as I feel that they will benefit the industry by reducing weight.

"I feel that we will soon get greater mileage and should double the life of any car. Some of the balloon tires I have inspected after they have been run 10,000 or 12,000 miles certainly indicated that the life of the balloon tires is as great as the life of the standard tire."

E. G. Gunn of the LaFayette Motors Corp. expresses the view that balloon tires "may have considerable effect on the adoption of steel disk wheels, especially on the front end with the steering knuckle set vertically and directly over the tire."

Question No. 16 was:

Do you expect use of balloon tires to result ultimately in a considerably lighter and more flexible car construction?

Replies lean rather toward the negative side, although a good number are in the affirmative. About 60 per cent answered "no," while most of the remainder said "yes," or qualified the reply to read "slightly" or "5 to 10 per cent," while one said "not necessarily." Still another is of the opinion that greater rigidity rather than than more flexibility is needed.

A tire manufacturer's view is given in the following quotation from S. P. Thatcher's reply:

"We fully expect the result to be ultimately a considerably lighter and perhaps smaller car, because of the weight which is now carried to provide a factor of safety."

Another tire engineer, J. E. Hale, expects use of the balloon tire to result in "entirely different spring suspension characteristics, more general use of rebound checks, a gradual lightening of parts, an entirely new treatment for the steering gear layout, the gradual elimination of front wheel brakes and much greater attention to improved comfort in riding."

WHAT'S the best diameter, width and type of rim for balloon tires?

That is the question many engineers and executives are asking today. Perusal of the information given in this article should help you to make up your mind even though the opinions expressed are somewhat conflicting.

The concluding question is closely related to the one which precedes it and reads:

What effect would such a construction be apt to have on the durability of the average car?

About half of the replies indicate an expectation of longer life. These are qualified in some cases by such terms as "materially," "much longer," "some improvement," etc., while others say the car should be designed for same life, and still others that durability will be increased if weight is not decreased, or that saving in weight may offset the increased life which otherwise might be attained. Another group consider the effect negligible, while those who foresee longer life expect also greatly decreased repair bills.

Views along somewhat similar lines are given in the following quotations:

"While it might be possible to build chassis lighter, I am inclined to feel that we should give the public the full benefit of the balloon tires. Not only from the easier riding standpoint but also a longer life to their car. Building cars lighter than present existing standard practice, I believe, would defeat one object of the balloon tires."—J. Rawley, Chief Draftsman, Dort Motor Car Co.

"Balloon tires will not offset a flexible frame or flexible construction, and body troubles will exist the same as without balloon tires."—W. D. Collins, Assistant Engineer, H. C. S. Motor Car Co.

In foregoing paragraphs we have what seems to us to be a good picture of the present status of the balloon tire. Generally speaking, it has been accepted by the automotive industry, but a number of problems connected with its use remain to be solved. Until these problems are fully met there is certain to be more or less criticism of the tire as well as the rim which carries it. Nevertheless the merits of the tire appear certain to bring about its ultimate adoption, possibly even to the exclusion of high pressure tires.

Those interested in further details revealed by the questionnaire will find many of them in the accompanying table, which, however, necessarily is condensed to confine it within reasonable compass.

Lighter Chassis Is Not Likely Until Body Weight Is Decreased

Advent of leather in place of steel panels are among the promising possibilities. Balloon tires, smaller wheels and tubular axles help decrease mass of unsprung parts. Present stiff and heavy frames are considered necessary to prevent wearing and rattles.

By W. L. Carver

IF one ounce could be removed from each part of the car, the total weight would be approximately zero. This statement was made about twelve years ago by a prominent automotive engineer. Since that time the industry has passed through alternating cycles of weight reduction and increase. For the past two years the tendency has been in the direction of increasing weight.

Brakes have been added to the front axle, the number of frame cross members has been increased and the side channels have been made deeper generally. Also the average length of wheelbase has increased while a general tendency toward heavier crankshafts and a greater number of crankshaft bearings has been shown. Each of these factors has had some effect in the direction of increasing chassis weight.

In spite of these general tendencies, it is necessary only to go behind the scenes to find that the same line of thought ultimately will result generally in chassis of lighter average weight than those of the present day. This result will be achieved, however, through the adoption of new features of construction rather than the evolutionary paring down of existing details. As a matter of fact, this latter process already has been tried and is largely responsible for the present reaction in the opposite direction.

Engineers generally are arriving at a clearer picture of the real purpose of the chassis and the elements which set up the requirements of design. With the present requirements but little possibility of weight reduction is offered, therefore attention is being centered now upon the their modification.

Consider the Chassis Weight

In consideration of chassis weight, every part of the car including powerplant, axles, frame and body must be included for, after all, the chassis is the entity which derives its characteristics from those of each detail. This idea is largely responsible for the thought which is being devoted to the study of requirements. Along with this, under the present conditions of price competition, any economy of weight must be absolute and not be obtained at the cost of scrap material and increased labor.

Aviation practice already has set up new standards of light weight, but as yet these are not generally applicable to car practice because the finished product is obtained after much of the original is machined away at an inordinate labor expense. Similarly, any change from cast iron to aluminum is not commercially feasible as long as the present prices and conventions of design prevail. Until the price of aluminum comes down to two or two and one-half times the cost of cast iron, its weight-saving characteristics are not really available to the builders of the lower and medium price cars.

For the past two years manufacturers have been concerned with absolute rather than the purely engineering economy of weight. For example, one manufacturer of frames has developed a method of forming the kick-up over the rear axle without the sacrifice of the amount of stock which usually is lost in the blanking operation for frames of this type. Ordinarily, the blank for the kick-up type of frame is stamped from a wider strip.

New Method of Stamping Kick-up Type Frame

In the new method the stock is but little wider than the developed length of the web and flanges of the channel at the deepest point. Before going to the forming dies, this strip is passed through a machine in which the required amount of offset for the kick-up is made by bending the stock edgewise. Similar economies have been effected by the swedging of rear axle shafts and coin press forming of connecting rods.

In spite of the tendency toward loading up of chassis, some development in the opposite direction is indicated. Rigidity is the chief result which is sought when weights are increased. An axle may be designed to carry all normal loads without permanent set or deformation and still be unsatisfactory due to its flexibility which causes trouble at the steering linkage.

A frame may carry all of its loads within the elastic limit of the material and still be so flexible that the body is racked and squeaks at every joint and door. In a similar way the crankshaft will carry its load and develop undue torsional vibration or the crankcase will ride on the crankshaft instead of providing a solid foundation for it. Considerations such as these are responsible for the present tendency to increase weight and at the same time they are leading engineers to look further afield for new types of construction.

Alloy Steel as a Remedy

Alloy steels have been suggested as the remedy for some of these structural shortcomings but their field of possibilities is comparatively limited as long as the present conventional standards prevail. When it is remembered that the modulus of elasiticity of all steels is practically a constant, the truth of this statement becomes more apparent. The alloy steel merely allows a greater range of deflection without permanent set as long as the same distribution of metal is used.

Rigidity can be obtained only by a greater mass or better distribution of metal regardless of the quality of steel employed.

Facts such as these are responsible for the increasing interest in tubular front axles as exemplified by the Chrysler six and a similar construction which has been used by Franklin for several years.

Both of these designs are lighter than the conventional I-beam construction. The Chrysler axle as illustrated by Fig. 1 weighs 27 lb., the tubing being a chrome-molybdenum alloy of 2¼ in. outside diameter and 5/32 in. wall thickness. The Franklin construction as illustrated by Fig. 2 is somewhat lighter, having the same outside diameter and a wall thickness of ⅛ in. The tubing in this case is .25-.35 carbon, 3½ per cent nickel steel alloy. The spring seats are .25-.35 carbon and the yokes are .30-.40 carbon, both being heat-treated.

Regarding this type of axle, Franklin make the following statement:

> "In comparing the cost of tubular construction: In general, the tubular construction is more expensive, approximately 50 per cent higher than the ordinary type of drop-forged axle. However, a drop-forged axle made out of alloy steel, properly designed, so as to give the same strength, would cost about the same amount, perhaps slightly less, but would be at least 25 per cent heavier. If made from ordinary material, the weight would run still higher."

Front Axle on the Chrysler

In the case of the Chrysler, which is equipped with four-wheel brakes, the drop-forged axle of conventional I-beam construction would be even heavier in order to carry the torsional stresses. In either case it is a question of locating the minimum mass of metal at the greatest distance from the neutral axis of the axle. Under these conditions the unit of deformation per unit of stress of the material instead of mere bulk becomes the determining factor for rigidity. Although the saving in the case of front axles will amount only to a few pounds, the reduction under the springs is particularly advantageous to riding quality.

A series of weight reductions below the springs is opened up by the small diameter tire. While each individual saving is small, the aggregate effect is considerable. Tire weight for example, will vary a little less than the diameter, therefore a reduction from a 32 in. to a 29 or 30 in. tire will mean a saving of about 6 to 8 per cent at this point. Reduction in rim weight is on about the same basis. As both of these weights rotate at rather high velocities with inertia effects that vary as the square of the velocity, savings at these points are reflected in the drive from the clutch back.

Small tires also effect a decrease of weight in wheels which is secondary only to that in tires and rims. Also, due to the fact that a smaller reduction can be used at the rear axle gears, it is possible in new designs to make a slight saving in gear material and if the diameter of the ring gear is reduced some slight weight can be taken off of the axle housing although the question of rigidity enters into the latter consideration.

Effect of Balloon Tires

Regarding the possibility of reducing chassis weight through the use of balloon tires, opinions are somewhat divided although a number of prominent engineers agree that no immediate saving can be made through the installation of balloon tires alone. In practically every case the line of reasoning is about the same, that is, that cars are not equipped with governors, therefore the driver will avail himself of the increased comfort possibilities of balloon tires and increase speed up to the point where the car has riding qualities similar to those with standard equipment at ordinary speeds. When this condition is reached, the impact loads imposed upon the various components of the chassis will be approximately equal to those which are the yard-sticks of present design.

Engineers from the purely engineering viewpoint are not altogether sold on existing balloon tires, but they feel that a real and permanent advance will grow out of the present agitation. It is felt that the range of inflation pressures will graduate from fairly high pressures for big heavy cars down to comparatively low pressures for very light cars with the greatest relative improvement in riding quality in the latter case.

One prominent car manufacturer in looking into the future in the direction of reducing chassis weight in conjunction with balloon tires suggests the possibility of the elimination of the conventional leaf type springs and their replacement by pneumatic cylinders along the lines of a combination of the Westinghouse and Lancia developments.

This latter assumption, however, is founded upon a construction in which the element of rigidity is or can

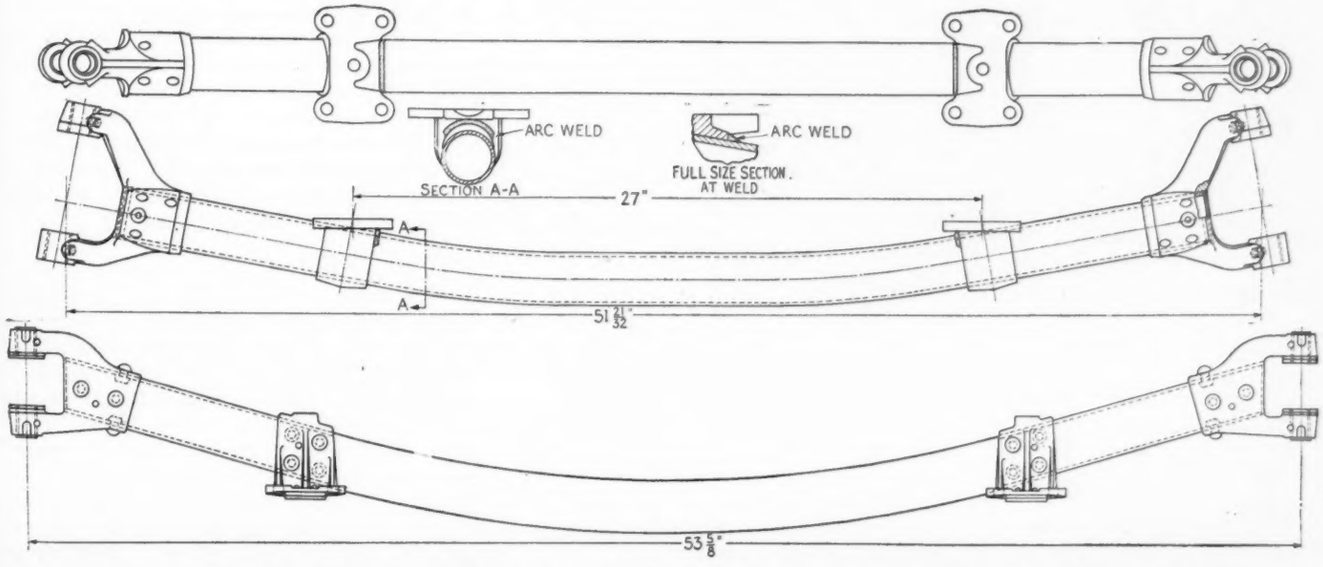


Fig. 1—Chrysler tubular front axle which weighs 27 lbs. and carries front brakes, viewed from the top and from the front. Fig. 2, bottom—Franklin front axle, which is somewhat lighter

be subordinated to lighter weight with the same or greater assurance of durability. In this scheme are included lighter powerplants and a different type of body construction as, after all, the frame portion of the chassis must be made rigid at present to properly anchor the powerplant and maintain proper alignment in the body structure, both of which are becoming to be regarded as being too heavy for the functions performed.

This trend of thought which underlies the present tendency to increase chassis weight leads to the field of predictions and hypotheses which are receiving a lot of concrete consideration.

Body Weight

Why should the weight of the body, particularly the closed body, be so much greater than the weight of the passengers carried? And why must the frame be made so heavy and rigid in order to carry this body? These two questions are playing an outstanding part in the consideration of future designs.

The answer to the first question is left wide open to developments in body design which probably will provide the answer to the second question, but the immediate specific answer to the second question is that frames have to be designed to accommodate bodies which must be heavy and rigid to fulfill the advance in customers' ideas. As long as metal covered bodies of the present type provide the only solution of continued quietness and appearance but little chance of reduction in chassis weight is possible.

Considerable progress toward the solution of these problems is indicated by the fabric body developments, chief of which are the Weymann and Fabric Body Corporation types. The Weymann type which constitutes a fabric enclosure around the interior arrangements has not received very marked consideration in this country as yet as engineers feel that the construction is too

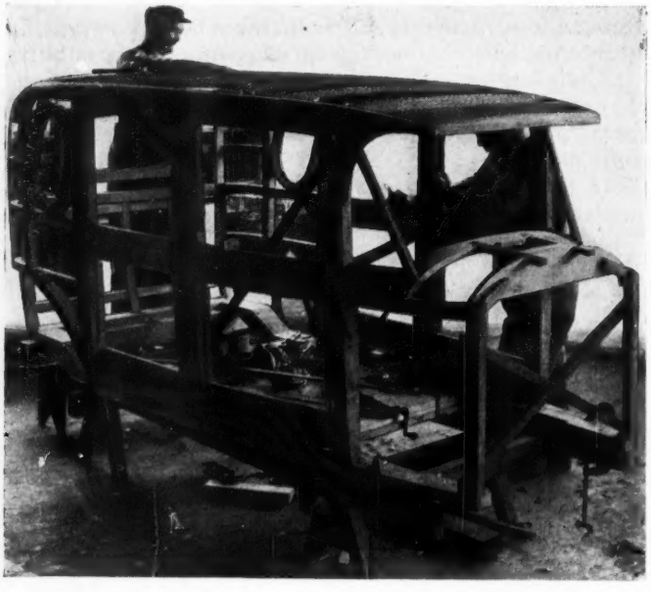


Fig. 3—Conventional wood frame of the Fabric body.

flimsy to stand up to our road conditions and lacks in appeal to the customer.

The entire construction is extremely light having light upright members which are tied together by the top members and sills to form a box section. No set-in joints are used in the construction, the various members being joined by light irons. The enclosure is altogether separate from the seats which are supported directly on the chassis. The exterior structure is designed to allow the maximum of weaving action without noise or squeaks.

One American engineer who has made a close study of the Weymann body abroad states that it is a lifesaver for many of the European manufacturers who are building four cylinder jobs as it eliminates the body squeaks and rattles which would otherwise occur due to the rough characteristics of their powerplants. Furthermore, no European manufacturer ever has approached the body manufacturing facilities which are available for any American plant and something had to be done to relieve this situation.

At present the fabric body designed by the Fabric Body Corporation is becoming popular among custom

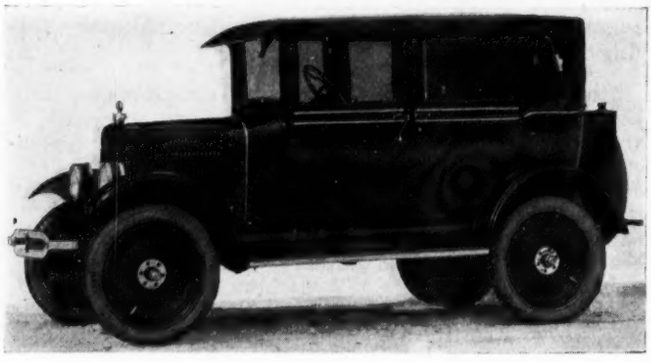


Fig. 4—Ford sedan body, which weighs about 125 lb. less than the standard body

body builders and at least two large car producers are giving this construction serious consideration to the extent of putting through sample lots. The frame construction of this type of body, as shown in Fig. 3, is conventional in every sense. A coat of wire netting is tacked over the frame and is followed by canvas which is stretched taut in place. This in turn is covered by two thicknesses of cotton wadding over which the leather fabric finally is tacked. The durability and permanence of this fabric coating is stated to be superior to the best varnish.

A custom body builder recently made a comparison between two similar jobs, both having the same wood frame, the first being finished in metal in the conventional manner and the second in fabric. The finished fabric body weighed approximately 150 lb. less than the metal finished body and the designers are confident that another 25 lb. or more can be removed without any sacrifice of quality. The special Ford sedan body illustrated in Fig. 4 weighs approximately 125 lb. less than the standard body and is somewhat roomier.

Weight reduction is secondary to the resilient characteristics of this type of body, also the elimination of any tendency to rumble. Body squeaks and rattles are entirely absent from the fabric construction, as the chafing action of metal panels is eliminated.

Resonance Avoided

As this construction does not include any resonant materials, the usual rumble is absent. It is fair to assume that a construction of this type would allow a reasonable reduction of frame weight. Possibly the gage of the side channels can be reduced and cross members can be decreased in number or weight.

Each reduction in unit weight along the line means that the engine is required to haul just so much less weight. When the weight and rigid characteristics of the body are reduced, a smaller lighter engine can be used for the same standard of performance. Following this a lighter frame can be employed to carry both of them on lighter axles.

At the present time, the body, which is the white elephant of both engineering and manufacturing, offers the greatest potential field for weight reduction, and when this is accomplished a whole chain of events is started which in the end will result in much lighter, more quiet cars. A 10 per cent reduction of body weight is easily the equivalent of 25 per cent reduction in the weight of any other major unit.

Engines are also the subject of a lot of thought which is outside the field of speculation. While the reduction of engine weight does not compare with that of body weight in importance, the present tendency indicates that within ten years engines of only a fraction of the present weight and similar if not better performance will be sold commercially. Racing practice is already showing the way by higher compression ratios and the advent of the supercharger. Furthermore, the distribution of fuels which eliminate the detonating characteristics of present day gasoline is becoming an established commercial fact.

It is estimated by the General Motors Research Corp. that the same performance can be expected of engines of 20 per cent smaller displacement with an increase of compression ratio to 6.5 to 1. Allowing for the same construction at the crankshaft and case, an appreciable saving is to be made in the pistons and cylinder casting. Then, again, the use of anti-knock fuel increases the possible compression ratios of supercharger engines, which are also somewhere near the point of commercial adaptation.

One prominent executive states that the supercharger will take from 50 to 80 per cent of the weight off of the present engine and that this will be followed by two-cycle supercharger engines which will make even further reductions for the same power output. The two-cycle supercharger engine built in the same number of cylinders as the present type of engine will also tend to cut down the magnitude of each impulse and double the number approaching something like turbine conditions. Consequently, many of the details of the drive back of the engine can be made lighter. The present tendency toward eight-in-line engines is a part of the program of reducing intensities and increasing the number of impulses.

Beginning with the body, every pound of weight which is saved is cumulative, and it is safe to state that the minimum figure which may be reached will be below what is regarded as being necessary now for good riding quality. At present, this particular phase of the trend of thought toward lighter cars is subordinated to the attention which is being given to other major units, particularly the body and the engine.

Nevertheless, engineers who have been interrogated as to the question of riding quality feel that this item will keep step with the balance of the campaign. The combination of balloon tires and air springs already has been mentioned as one possibility, and European engineers already have developed springs equipped with Ferodo brakes which can be adjusted for the desired action. Two or three developments in which lateral springs replace the axles, thereby eliminating the major factors of unsprung weight, also show some promise.

Tunnel Built to Determine Air Resistance of Automobiles

ABOUT two years ago preparations were made at the Engineering Experiment Station of Kansas State Agricultural College to determine the air resistance of automobiles in a novel manner. A heavy galvanized iron tank, 17 ft. in diameter by 3½ ft. deep, was sunk in the ground and partly filled with water, and inside this tank was floated a similar one of 16 ft. diameter and 2 ft. depth, with a wooden deck or platform onto which an automobile could be run. Water was then added to the larger tank until the platform was just even with the ground. The force exerted on the automobile by natural winds was measured by means of a recording scale inserted in a wire leading from the front of the automobile to a post set in cement near the edge of the large tank.

Wind speeds were measured with an anemometer, and from the results obtained it was attempted to determine an expression for the relationship between the wind speed and the air resistance or drag on the car. The formula arrived at was

$$F = 0.0012\ A\ V^{2.383}$$

in which A is the projected frontal area of the car in square feet and V the wind velocity in miles per hour.

This equation differs considerably from that in common use, the theoretical coefficient of the velocity for air resistance being two. It was realized that the method of measurement employed was rather crude and that errors were introduced particularly by the unsteadiness of natural winds. It was therefore decided to build a wind tunnel of sufficient size to test full-sized automobiles in. Particulars of the plan are given in Bulletin No. 43 of the National Research Council, from which we take the following:

This wind-tunnel, which is now nearing completion, differs from the usual type of wind-tunnel in two respects: First, the cross-section is rectangular instead of circular; second, the testing portion, where the car is placed, is enlarged in order that the air speed in this section will not be increased by the presence of the car. The cross-section of the tunnel ahead of the enlarged portion is approximately 12 ft. wide and 10 ft. high, while the entire length is about 40 ft. The enlargement, which is made on the two sides and top, is approximately 9 in., making the test portion of the tunnel approximately 10 ft. 9 in. high and 13 ft. 6 in. wide.

The amount of enlargement was calculated from the average of the projected areas of a large number of different kinds of automobiles. This area was traced with a planimeter from a plot of the car made with a camera lucida. The entrance of the tunnel is flared to admit the air freely, the size of the opening being 12½ ft. high by 17 ft. wide. The exit end tapers down to a circular section 10 ft. in diameter. An ordinary airplane propeller is used for a fan.

The platform on which the car is tested rests on long beams supported by chains from an outside framework. The zero position of the platform is determined before the fan is started. The fan is then started and, as the wind velocity is increased, the pull required to return the platform to its zero position is determined for each increment of velocity.

Although no complete tests have been made as yet, enough data have been taken to indicate that the tunnel may be expected to give satisfactory results. A wind velocity of 16 m.p.h. has been obtained, and a study of streamers placed at various points in the tunnel indicates that the air currents are sufficiently uniform for the purpose. The chief difficulty at the present time is the lack of a fan of the proper design.

What Basic Materials Go Into Automobile Finishes?

Purchase and application in the future will be based on exact specifications.

MANY millions of dollars are spent annually for materials used in the finishing of automobile bodies and chassis, yet there is an amazing lack of information concerning the real nature of these materials, not only among those why buy and use them but among engineers who have a reasonably good knowledge of practically all other important materials which enter into the construction of motor vehicles.

Since there are few more important factors in the sale of new cars than that of a satisfactory finish, it is important that all who have to do with the specification, purchase and application of finishing materials form as clear a conception as possible as to the nature and characteristics of these materials.

Unfortunately the literature of the art is decidedly meager and only in recent years have manufacturers of finishing materials begun to give information regarding their product which is comparable with that concerning most other materials used in automobile construction. Much of the data which are available are now out of date because of the rapid advance in the art made in the last two or three years, though most of the same basic materials still are employed.

Under these circumstances it has seemed useful to collect in the following pages certain elementary facts which will serve as a ground work for gaining a more nearly complete knowledge of the subject. Much of the information given will not be new to those well versed in the art, but should prove useful to others who are seeking better general information as to types of finishes in commercial use today and the materials which enter into their manufacture.

Chemical Control

Not until quite recent years have many makers of finishing materials come to realize the need for a strict chemical control of their production. Such a control is now maintained in some plants and is likely to be almost universal in the near future. A similar control of the purchase and application of finishing materials is now in contemplation among some large automotive manufacturers and is a likely outgrowth of the tendency toward more scientific methods in all industrial work.

This is apt to lead in time to more precise definitions and specifications covering various types and grades of finishing materials which will prove of benefit to both manufacturer and user of these materials. One primary requisite to the formulation of such specifications is a knowledge of the materials which are to be employed. It is hoped that the following particulars will prove useful as a first step in providing a better understanding of the subject and in helping to remove some of the mystery which is supposed to surround the paint and varnish industry.

At the present time there are used in the automotive industry two distinct types of finishing materials. The older and more widely used of these includes all finishing materials chiefly composed of linseed and other oxidizing organic oils, metallic driers, resins and volatile thinners. All ordinary paints and varnishes come under this heading and are often termed oleoresinous products.

Oleoresinous finishes dry partly by evaporation of solvents, such as turpentine, used as thinners and partly by oxidation. Various substances known as driers are used to accelerate the drying process.

Cellulose Nitrate Finishes

The second general class of materials employed is comparatively new in the automotive industry. It is the cellulose nitrate or pyroxylin group. The basis of these materials is cotton fiber which has been treated with a mixture of nitric and sulphuric acid to form a nitrate and thus is rendered soluble in various volatile liquids, such as alcohol, acetone, ether, amyl acetate, etc.

This class of materials dries entirely by the evaporation of the volatile solvent and the process does not involve any oxidation or chemical change in the remaining film.

Inasmuch as the film left by the drying of either an oil-varnish or a cellulose nitrate lacquer is more or less transparent, it usually is necessary to combine with these materials pigments which hide the surface to be painted and give it such color as is desired.

In the case of varnish finishes the final coat or coats usually are clear, but since clear coats of pyroxylin (cellulose nitrate) finish quickly deterioriate when exposed to sunlight the final coats of this material usually contain more or less pigment which affords protection from the sun and renders the finish highly durable.

In the following paragraphs we shall consider first the linseed oil and second the cellulose nitrate finishes. Most of the information given is drawn from the following sources:

Technique of Paint and Varnish, by A. H. Sabin.

Rubber, Resins, Paint and Varnish, by S. R. Morrell.

Oils, Pigments and Varnishes, by R. H. Truelove.

Paints, Vehicles, Japans and Varnishes, by C. D. Holley.

Chemistry of Paints, Pigments and Varnishes, by J. G. Bearn.

Painters and Decorators Materials, by R. V. Cooper.

Several papers by L. V. Pulsifer presented before the Society of Automotive Engineers. The author is greatly indebted to Mr. Pulsifer also for valuable suggestions and information which would not otherwise have been available.

Linseed oil is a yellow-brown or greenish-yellow oil of low viscosity which is pressed from the seed of flax. It is refined by certain acid or alkali processes and by heating or tanking for many months to allow foreign matter to separate and settle out. The raw oil dries too slowly for most uses in paint and therefore usually is boiled with an admixture of driers which cause it to oxidize and "dry" more rapidly.

Boiled linseed oil is darker in color than the raw oil. When exposed in a film to the air it dries with a hard lustrous surface. The dried film is termed "linoxin."

Character of Linseed Oil Varies

The character of linseed oil varies to some extent with the locality from which it comes. Both the Federal Government and the American Society for Testing Materials have issued standard specifications for linseed oil. According to the latter, the specific gravity at 60 deg. Fahr. is 0.936 max. and 0.932 min.

Linseed oil is used as the vehicle in nearly all paints and varnishes employed in the automotive industry, with the exception of the cellulose nitrate materials. Not infrequently, however, it is mixed with other oils of a somewhat similar character, especially in the manufacture of varnish. The most important of these is tung or China wood oil.

Tung or China Wood oil is pressed from the nuts of the China wood tree, grown extensively in China and to a limited extent in other parts of the world. Cold pressed oil is pale in color, but the hot pressed oil is dark. This oil dries in about two-thirds the time required for drying raw linseed oil. If dried at ordinary atmospheric temperatures the film is white, dull, opaque and crinkled, but if dried at temperatures above about 175 deg. Fahr. the film is smooth and transparent. This oil requires careful heat treatment before use in either paint or varnish.

Tung oil has a slightly higher specific gravity than linseed oil. A. S. T. M. specifications call for a gravity, at 60 deg. Fahr., of 0.943 max. and 0.939 min.

Tung Oil Films

Films formed by the drying of tung oil at ordinary temperatures tend to pucker or web, especially if drying is retarded by a gas laden or foul atmosphere. The oxidized film is, however, more resistant to moisture than linseed oil films—a fact which accounts in part for the use of tung oil in water resisting spar varnishes.

One authority states that tung oil films compare favorably with that formed by linseed oil and gum-resin varnishes and that it is said to possess lower susceptibility to cracking at low temperatures. Another says the film does not bloom as do most varnish films containing much oil, but is made more elastic by linseed oil. Tung oil films grow harder and tougher as time passes and afford good resistance to abrasion and scratching.

Turpentine, properly referred to as spirits of turpentine, is a product of the distillation of oleo-resins flowed from pine trees. It is a volatile liquid which evaporates readily at ordinary atmospheric temperatures and distills almost completely between 150 and 170 deg. C.

A. S. T. M. specifications call for a specific gravity of not less than 0.862 or more than 0.872 at 60 deg. Fahr. and state that the liquid should be clear and free from suspended matter, and should have a sweet pleasing odor, not a pungent or offensive creosote odor. Initial boiling point shall be below 160 deg. C. and a minimum of 90 per cent shall distill below 170 deg C. (Note: Some large purchasers of turpentine spirits specify that 95 or even 97 per cent distill below 170 deg. C.)

A product termed "wood" turpentine is obtained from resinous wood either by use of a volatile solvent or by destructive distillation. This product comes within the accepted physical and chemical limits of "gum" turpentine and therefore should be covered by the same specifications.

Turpentine substitutes are used in large quantities. They usually contain large proportions of volatile petroleum distillates (benzine or naphtha), but often have the odor of turpentine due to an admixture of this liquid. They are not, however, such good solvents for gum-oil mixtures or metallic resinates and linoleates present in varnishes and Japans as pure turpentine. They should be of such a character as to evaporate at ordinary atmospheric temperatures leaving little or no residue, be free from acid and sulphur and should distill as near the spirits of turpentine range as possible.

Among the well known turpentine substitutes is a petroleum distillate known as "white spirit." The distillation points of this substitute are given as 145 to 210 deg. C.

Driers is the name given to lead, manganese and cobalt compounds which impart to linseed and other organic drying oils or varnish the property of more rapid oxidation. They are supposed to act as catalytic agents, remaining chemically inactive but promoting much more rapid oxidation than otherwise would take place.

Driers in more or less general use include the various salts and oxides of lead, manganese and cobalt. The proportion of driers used in automobile finishes usually is held to a minimum consistent with the rate of drying required, as driers tend to increase brittleness and decrease the life of the finish.

Japan. The term japan often is used synonymously with the term drier. This class of japan is defined by one authority as follows: A compound resinate made by adding lead or manganese to common rosin or colophony, and which, when diluted with turpentine or benzine, possesses some of the qualities of varnish and not only dries quickly itself, but imparts that property to paint or varnish to which it is added.

Color Pigments

Pigments are materials used to impart color to the object painted. When mixed with oil they form paints and when mixed with rubbing varnish they form color-varnishes. When mixed with finishing varnish they form enamels. In general pigments are finely ground materials which, when mixed with oil or varnish, remain in suspension in it but do not go into solution.

Most pigments possess a natural mineral color which they impart to the paint or varnish, thus white lead makes a white paint, carbon black a black paint, chrome yellow a yellow paint, etc., but some pigments termed *"lakes"* are colored artificially by precipitating a die on a more or less inert white base such as barites, china clay or alumina. A great number of pigments are employed to produce

WHAT goes into automobile finishes is a question that would stump many an engineer and executive in the automotive industry even though he often spends tens or hundreds of thousands of dollars a year for products in this class.

It stumped the author of this article until he started digging for the information set down here for your benefit. None of it is new but we have yet to find another single article or even a book which contains all the facts included in this useful summary.

various colors. These pigments usually are first ground dry and then are ground in japan or varnish until the desired degree of fineness is secured. In general the finer the grinding the brighter the color and the better the covering qualities.

Color is the term applied to a pigment ground in oil and thus rendered readily miscible with oil to form a paint.

Japan color is pigment ground in a rapid drying japan. When thinned with spirits of turpentine it is used as a so-called "body" or ground color and is mixed with varnish to form a color-varnish. Many automobile finishers prefer to buy the color and mix it to form color-varnish themselves, but others buy the color-varnish mixed and ready for application. The grinding japans in which such colors are ground is a sort of varnish loaded nearly to the saturation point with lead and manganese or cobalt driers.

Japan Color Coats Produce Mat Surface

Coats of japan color used in automobile finishing dry with great rapidity, producing a non-lustrous or mat surface which should be semi-porous in nature to permit the succeeding coat of varnish to penetrate it to some extent. These color coats are the least elastic of all the materials used in varnish finishing systems.

Gums or *Copals* are the names applied to the resinous materials which form one of the important ingredients of varnish and usually are divided into two classes: so called "fossil" gums and products of living trees. Those of prehistoric or "fossil" origin are harder and better. They come largely from Africa, New Zealand and the East Indies, and include Zanzibar, Congo, Manilla and Kauri. They are the exudation of prehistoric trees. Gums of recent origin are softer. They include juniper gum, called sandarac, mastic and dammar as well as benzoin, anime and ordinary rosin or colorphony, which is the residue left after distilling turpentine spirits from the natural resin of the long leaf, yellow pine, or, as it properly is called, turpentine.

Having defined and given briefly the characteristics of the various raw or semi-finished materials used in the manufacture of what are termed oleoresinous finishes it remains to discuss the finished products. Of these perhaps the most important are varnishes.

Classification of Varnishes

Varnish may be defined as a clear limpid solution of resinous matter in a fixed vegetable drying oil and solvent volatile thinner capable of forming on exposure to air a hard transparent film. One authority classifies varnishes as follows:

1. Those which consist of linseed or other drying oils and thinners, the hardness of which may be increased by addition of such materials as gum-resins, copals, rosin, etc.
2. Those which consist of a solution of resin in a volatile solvent.
3. Those which consist of a natural product of a tree, drying by enzyme action; for example, Chinese, Japanese and Burmese lacquers.

The automotive industry is concerned only with the first class. It consists of a drying oil or oils which give elasticity, resins which themselves are devoid of elasticity but give hardness, gloss and resistance to atmospheric effect; volatile solvent, usually turpentine, which reduces the whole to a workable consistency and driers, which aid oxidation of the film.

Not only is the character and proportion of each ingredient important, but the manner in which they are "cooked" and blended. For this reason it is said to be futile to frame a specification for varnish which simply names the ingredients and the proportion of each. Skilled varnish manufacturers state that it is possible to make either a very poor or a very good varnish from identical ingredients, depending on what has been termed the heat treatment of the components.

Varnishes used in automobile finishing fall into two general classes: Those that contain less oil than gum are termed "short-oil" varnishes and are the rubbing varnishes. Those that contain more oil than gum are "long-oil" varnishes. All finishing varnishes are in this class.

Quickest Rubbing Varnishes

According to L. V. Pulsifer:

> "The quickest rubbing varnishes sometimes have as much as two parts of gum to one of oil. Three and four-day rubbings are on the border line between short and long oil varnishes. Finishing varnishes range from quick gear varnishes, containing about two parts of oil to one of gum, up to body varnishes running as high as four or five parts of oil to one of gum.
>
> "Of course, the character of the individual materials and the processes by which they are combined, as well as the proportions in which they are 'alloyed,' help to determine the quality of the finished varnish. Considering materials of similar quality, the short oil varnishes are quick setting, fast and hard drying, inelastic and, if exposed to the weather or even to extreme changes in temperature without protection of a long oil varnish, will soon crack and perish.
>
> "On the other hand, the long oil varnishes work freely, flow smoothly, set slowly, dry and harden gradually and possess a high degree of elasticity. The higher the percentage of oil in their composition, the greater is their degree of elasticity and durability. They do not, of course, dry hard enough or fast enough for use in the rubbing coats, but they possess the durability necessary to afford the final protection for the whole paint structure.
>
> "The Japan drier or grinding japan used in the japan colors and some of the other automobile undercoats is really either a long or a short oil varnish in which is incorporated a very high percentage of metallic drier. This causes the film to dry with much greater rapidity than would be the case with a normal varnish of the same gum-oil ratio and, at the same time, reduces the elasticity very greatly.
>
> "In the production of high grade varnishes extreme care is necessary in the selection and testing of all the raw materials; in the aging, refining, bleaching and heat treating of the oils and in the melting of the gums and their combination with the oils. Careful testing of the base, or primary, varnishes, their proper storage and selection for the blending or mixing process in the formation of the secondary or finished varnishes, and finally, the rigid check testing against standard of each tank of the finished product, form an essential part in the production of reliable material.
>
> "Body varnishes should be chosen for their paleness of color, freedom and safety of working, speed and perfection of flowing, time of drying and hardening in relation to durability, fullness of body and brilliancy of finish. A different type of finishing varnish should be chosen for the hood, fenders and wheels from that used on the body, for one is needed that is more resistant to the action of mud, water, oil, grease and soap than is required on the body. A varnish of this type does not possess the freedom of working and flowing of the finest grades of body varnish, but, fortunately, the surfaces to be finished are much smaller and working qualities can be sacrificed safely to obtain greater body, toughness and resistance."

Color-varnishes are simply rubbing varnishes to which is added a pigment which either is ground into the varnish by the manufacturer or is mixed with the rubbing varnish by the user in the form of a japan color.

To produce a satisfactory body finish the varnishes must be applied over a suitable surface which, in general, consists of a priming coat, one or more surfacing coats, some-

times including a sealer, and one or more coats of flat color, variously termed ground color, japan color or body color.

Primer is the name given to the initial coat which is applied to the bare wood or metal and forms the bond between the surface to be finished and succeeding coats. Metal primers usually consist of a mixture of linseed oil or varnish with a pigment such as white or red lead, the proportion of oil being quite high in order to give the necessary elasticity and permit the primer to expand and contract with changes in temperature of the metal.

Surfacers or So-called Roughstuff

Surfacer or *roughtstuff* is the term applied to coats which follow the primer and are used for filling or building up a smooth surface on which to apply the color. The aim is to make a material which will dry rapidly and give a hard surface capable of being ground to a glossy, smooth surface at the same time having a flexibility only a little less than that of the primer over which it is applied. Some consider it desirable to have the coat next to the primer composed of half primer and half roughstuff.

Roughstuff usually consists of siliceous matter (some mineral silicate, such as slate, ground to moderate fineness), some white lead (about one-third to one-quarter by weight) mixed in rubbing varnish or linseed oil containing considerable japan drier. Some consider ochre a valuable ingredient. Usually surfaces are sold in paste form intended for thinning with spirits of turpentine. A color roughly matching the succeeding color coat sometimes is added.

There are two varieties of surfacing material: those intended for surfacing by sandpaper, often termed "sanding surfacers," and those called roughstuff intended to be rubbed down with block pumice or rubbing stone and water. The latter are said to be tougher, more dense and more durable, though requiring more time and labor.

Putty and *putty glaze* are preparations usually mixed in a very thick or viscous paint form and are intended to fill up comparatively large depressions in the surface. They are applied over the roughstuff and, of course, are required only when large irregularities are present. As a rule they contain a high percentage of white lead or other pigment mixed in a binder of rubbing varnish or linseed oil containing a high percentage of japan drier. One formula for putty of this kind provides for using three parts of dry white lead to one part of lead in oil and thinning this with a mixture of equal parts of japan and rubbing varnish until the consistency is such that, after thorough kneeding, it can be handled without sticking to the hands.

Putty and putty glaze usually is applied with a broad blade flat knife.

Sealers Add Life and Toughness

Sealers are intended for application over roughstuff, to fill its "pores," give it added life and toughness and to prevent too great absorbtion of subsequent coats.

Sealers usually are similar to a thin, rapid drying elastic varnish.

In the foregoing paragraphs we have referred primarily to materials used chiefly in the orthodox varnish systems of painting. Some of the same materials are used also in the baked enamel systems which are employed for many large production open car bodies, for some closed bodies and for nearly all such body parts as fenders, splash aprons and similar sheet metal parts on cars of practically every class.

Baking enamels, until quite recently, have been confined, so far as the automotive industry is concerned, to black which is capable of being baked for several hours at temperatures which usually run anywhere from around 250 up to 500 deg. Fahr. for periods of three-quarters to three hours or more. In quite recent months there have been developed a few colored baking enamels, but since these are not yet very widely used in the industry and since they have been described quite fully in these columns recently* further mention will not be made of them in this article except to say that they consist chiefly of tung oil varnish and carefully selected pigments in a limited number of colors which stand a baking temperature of about 275 deg. Fahr. without serious discoloration. Present indications point to an increasing use of these colored enamels in the future.

Black baking enamels have two primary advantages: first they lend themselves to rapid production, since they can be flowed on or applied by dipping, dried rapidly and require little if any rubbing; second, they produce one of the toughest and most durable finishes known. One which adheres tenaciously to the metal, does not crack easily and carries a high lustre which can be renewed by polishing when it becomes dull.

These black baking enamels sometimes are termed *japans* or *bituminous varnishes* and are characterized by their bitumen or asphaltic content. The vehicle is a specially treated vegetable drying oil (tung and linseed oil are employed) and a portion of hard drying copal varnish is used to impart lustre and durability.

Black Baking Japans and Enamels

One formula for a high grade, black baking enamel calls for approximately 100 lb. of asphaltum, 40 gal. boiled linseed oil, and 60 gal. suitable thinner, together with a minimum of drier.

Black baking japans differ from black enamels in that the black finish is of partial translucency, while the pigmented enamels are opaque and appear to reflect their color from the surface only.

The terms enamel and japan used in this connection appear to be more or less interchangeable, however. These materials differ widely in composition. It is worthy of note that the asphaltic content actually enters into solution, while black pigments do not do so. This may account for differences in translucency.

Enamels of a character not intended for baking are used in automobile finishing and refinishing. They are made in a wide variety of colors and usually consist of a fairly long oil varnish containing a very finely ground pigment. A good pigmented spar varnish, that contains a considerable proportion of tung oil which imparts moisture resisting qualities, frequently is used. If the ingredients and manufacture of such an enamel are such as to give a film of high elasticity, such a finish is highly durable partly because of the elasticity and partly because the pigment

FEW materials used in the manufacture of passenger cars are so little understood as those applied in finishing the body and chassis. Authoritative information on the subject is seldom seen in print although it is recognized that few items have so much to do with the sale and resale of the car as the finish.

With these facts in mind we have collected in this article some elementary information on the subject which we believe will interest both the engineer and executive.

*See AUTOMOTIVE INDUSTRIES for Feb. 14, 1924, p. 324 and Apr. 17, 1924, p. 859.

helps to protect the varnish from the destructive action of ultra-violet rays in sunlight.

The term enamel is applied also to cellulose nitrate finishing materials containing pigment.

Lacquer is defined by the Century dictionary as an opaque varnish, containing lac, especially the kind of varnish containing shellac dissolved in alcohol with the aid of other ingredients, particularly coloring matters.

Lacquer of this kind is not used in automobile finishing, partly because it does not resist the action of the weather sufficiently well. Pigmented pyroxylin lacquer an entirely different class of material, now is being used with considerable success for body finishing. Such lacquer is described in the following paragraphs.

In the foregoing we have considered almost entirely materials used in admixture with drying oils, especially linseed oil, which oxidize when drying and continue to oxidize slowly throughout their life. We now come to the consideration of an entirely different class of finishing materials which do not oxidize in drying, but dry only through evaporation of the solvent employed. We refer to cellulose nitrate materials otherwise known as pyroxylin finishes.

Cellulose Nitrate

Cellulose nitrate is the name applied to a material made by treating cellulose, that is, cotton or other woody fiber by nitric or a mixture of nitric and sulphuric acid and thus rendering it easily soluble in volatile liquids such as alcohol, acetone, ether or amyl acetate, commonly called banana oil, because its ordor is similar to that of the banana.

The chemical formula of cellulose nitrate is $C_{12}H_{21}O_6$ (OH) $(NO_3)_6$.

One authority states that this chemical compound when dissolved in three parts of ether and one of alcohol leaves, upon evaporation a harsh, brittle film which dries porous and opaque due to presence of water condensed and deposited within the film. Brittleness can be modified by addition of castor oil and Canada balsam and the tendency to dry opaque can be modified by use of amyl acetate in place of ether and alcohol. The same author says that the film must be protected from destruction by ultra-violet light rays by a pigment.

Cellulose nitrate dissolved in an alcohol-ether mixture forms collodion. A film of this material is not suitable for automobile finishes, but the basic cellulose nitrate with proper solvents and the admixture of other materials to give such elasticity as is required and to protect the film from the action of ultra-violet light rays, which are present in the light of the sun, does give an exceedingly durable film.

Similar to Coated Fabric Films

Similar films have long been used in the automotive industry for coating fabrics to form a highly durable, artificial leather, but their use in body finishing on a production scale started less than a year ago. They have been used for many years, however, for finishing metal surfaces, as on brass and silver articles. In localities where alkali dust has proved very destructive to ordinary finishing materials, cellulose nitrate finishes have been used with considerable success in refinishing automobiles for a number of years.

Wider use, especially in production, is said to have been prevented by inability to dissolve more than a small percentage of solid matter in the solvent without making a lacquer which was too viscous to be applied satisfactorily. Since with this type of finish the solvent evaporates completely, the film of solid matter which remained was exceedingly thin, consequently a large number of coats had to be employed to build up a film of the desired thickness.

Comparatively recent developments are understood to have overcome this disadvantage and to have brought about a rapidly growing demand for this class of material. Given a suitable surface, produced by the correct type of primer and surfacer, about three spray coats of pigmented cellulose nitrate lacquer or enamel, as it sometimes is called, are sufficient to give the necessary thickness of coating. Such a coating is exceedingly resistant to action of the elements, so hard as not to be easily scratched and consequently very durable.

Rapid Drying at Average Temperature

One of the chief advantages of this finish is the rapid rate of drying at ordinary temperatures. Several coats can be applied in a single day without artificial drying and the process can be hastened still further by drying at temperatures up to 125 deg Fahr.

Cellulose nitrate finishes dry with a rather dull luster which can be rubbed to a good polish with wax. If a still higher luster is desired it can be obtained by using coats of finishing varnish, such as is used for the final coat in the oleoresinous type of finish. In this case, the rubbing with wax would, of course, be omitted. For best results two coats of varnish should be used over the nitrocellulose.

Pigments used in the preparation of cellulose nitrate lacquers are, in general, the same as those used in linseed oil finishes, but, as a rule the colors are ground in a fairly thick pyroxylin jelly instead of in oil, varnish, or japan.

Thinners or volatile solvents used to reduce pyroxylin finishes to the proper consistency for spraying are usually amyl acetate, commonly called banana oil, alcohol, acetone and ether, or mixtures of these materials. Ether and alcohol evaporate so rapidly, however, that they cause a refrigerating action sufficient to condense moisture out of the air, especially in a humid atmosphere. This moisture is formed both in the spray and on the surface being finished and is entrapped in the rapidly drying film with detrimental results. On this account amyl acetate, which evaporates much more slowly, is to be preferred, although it is more expensive. Some conditioning of the air may be required, even with a high percentage of amyl acetate, however, when the air is nearly saturated with moisture.

Primer and Filler Coats

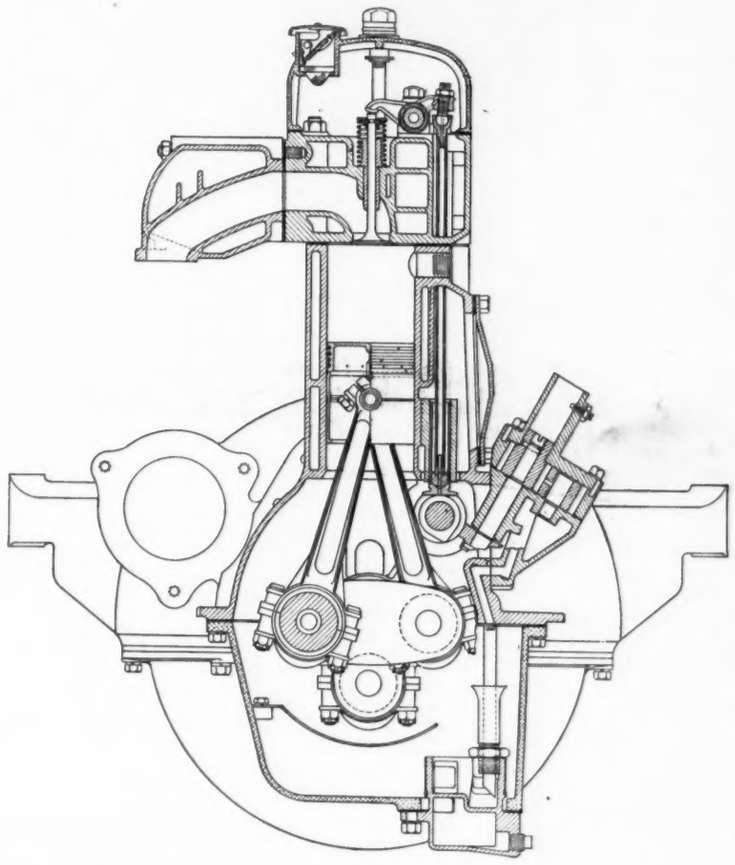
Primer and *filler* coats of the same materials used with the conventional paint and varnish finishes are being used successfully under final coats of pyroxylin lacquer, but since the solvents used in these lacquers are the same materials employed in paint removers, a softening of the undercoats is apt to occur, unless these are force dried or baked to a very hard film. Partly for this reason, manufacturers of cellulose nitrate finishes now are putting out primers and roughstuff with pyroxylin instead of linseed oil as a vehicle. Aside from the vehicle, these materials are much the same as those used with linseed oil finishes. A priming coat of baked enamel is said to have been used with success under pyroxylin finishing coats on low-priced, large production jobs.

Cellulose nitrate finishes for automotive use have not yet undergone the same lengthy development nor seen the years of practical service which paint and varnish finishes have been subjected to, but results obtained to date are exceptionally promising.

A TENTH progress report has been issued by the Gage Steel Committee of the Bureau of Standards. It comprises a Preliminary Report on Wear Tests of Gage Steels by J. R. Freeman, Jr., and S. J. Rosenberg; Lapping Wear Tests of Gage Steels by D. R. Miller and Time Changes by H. Scott.

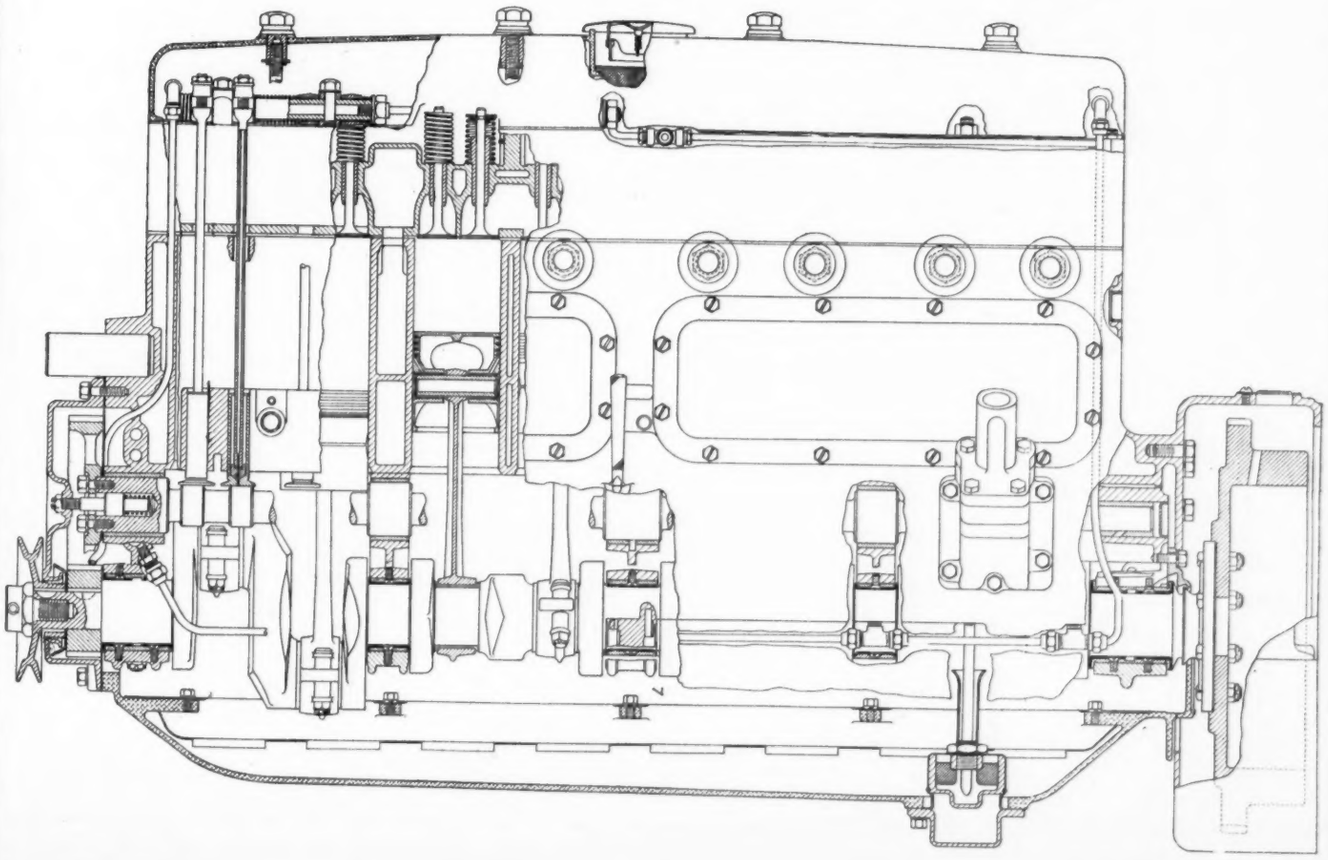
Eight Cylinder Vertical Engines

MANY engineers are working on designs for eight-in-line engines at this time. The following pages contain sectional drawings of most of the engines of this type in use in the United States and abroad. They are published as ready reference material for the design engineer.



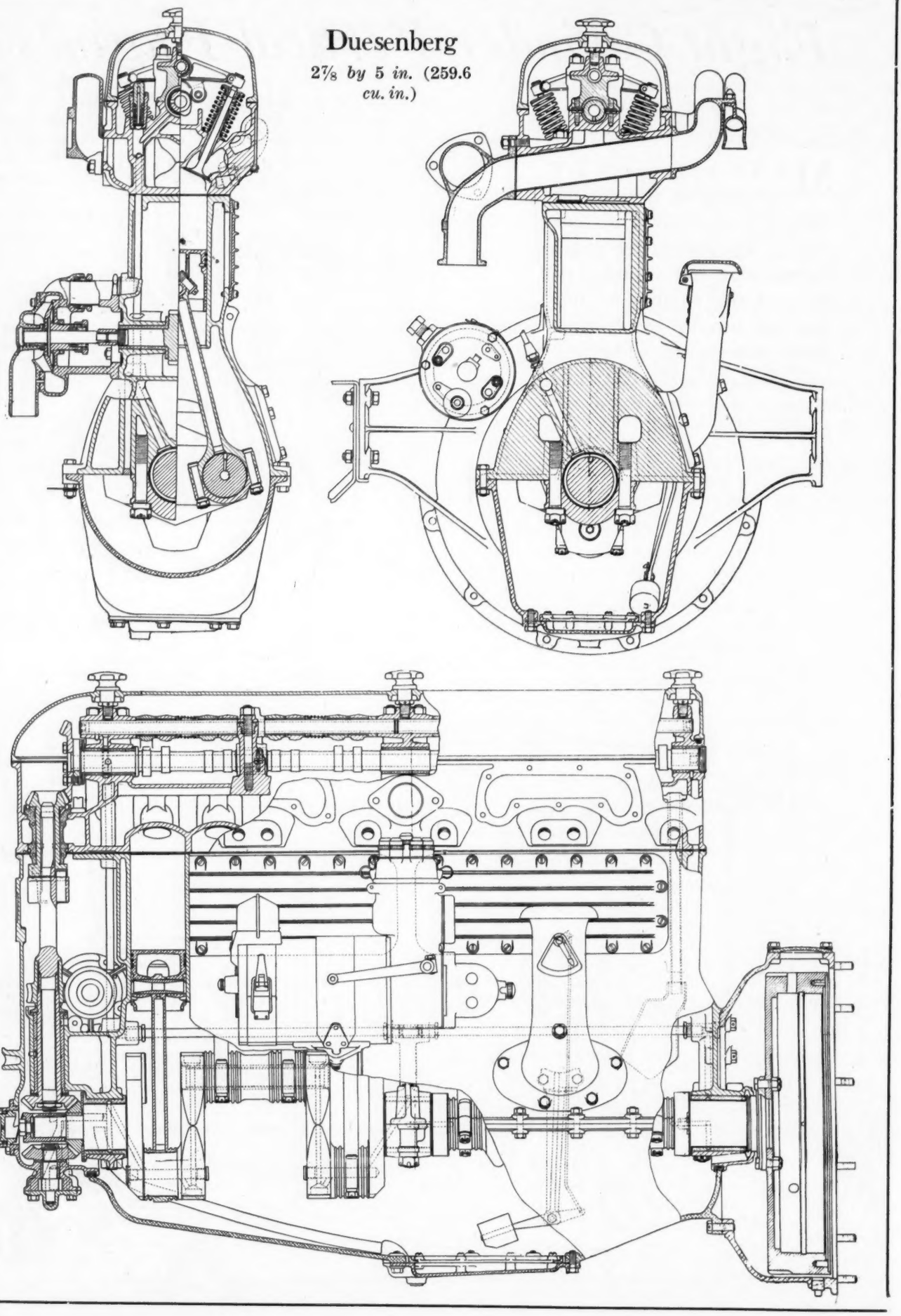
Falls

3⅛ *by* 4¼ *in.* (260.8 *cu. in*).



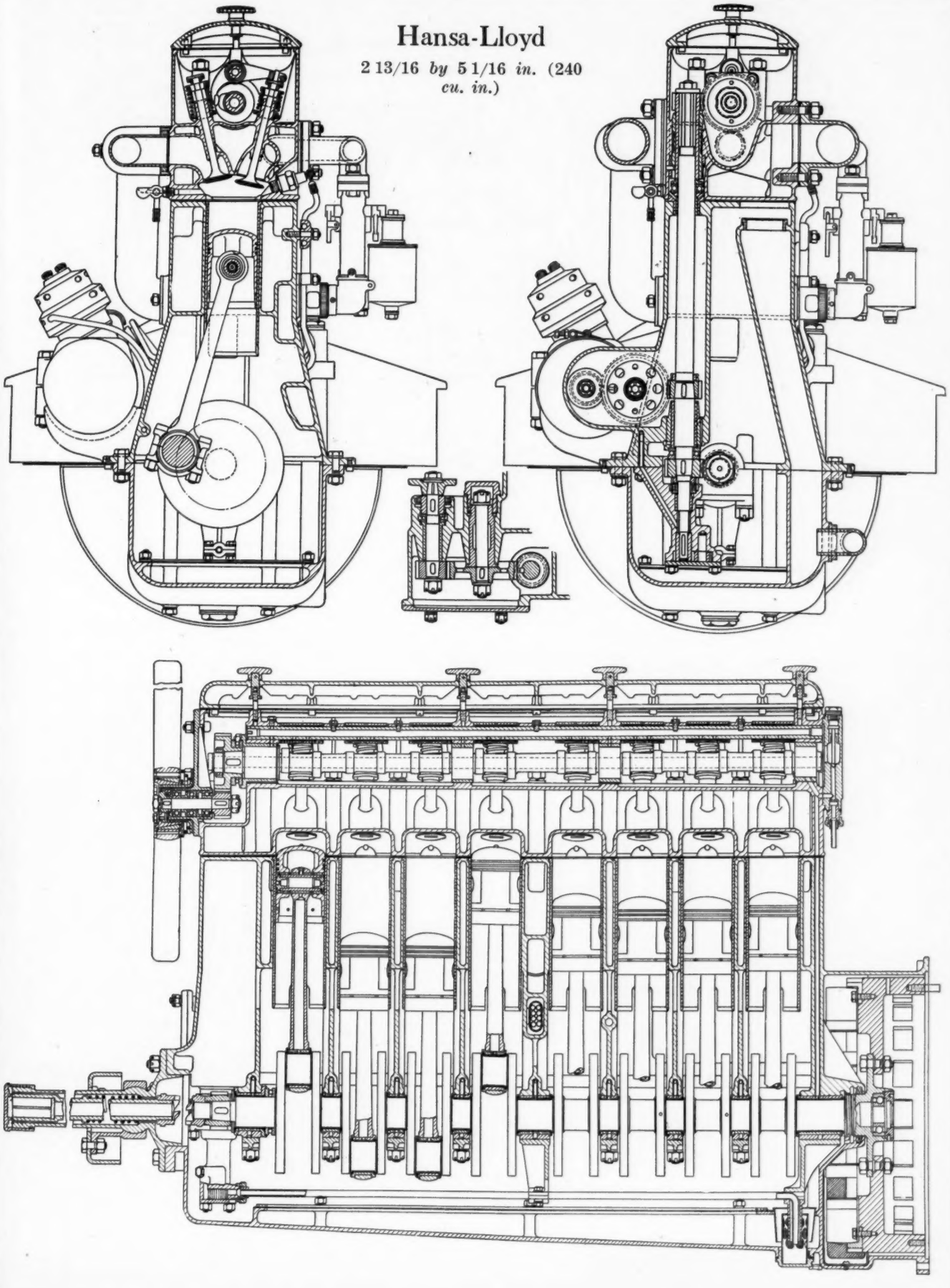
Duesenberg

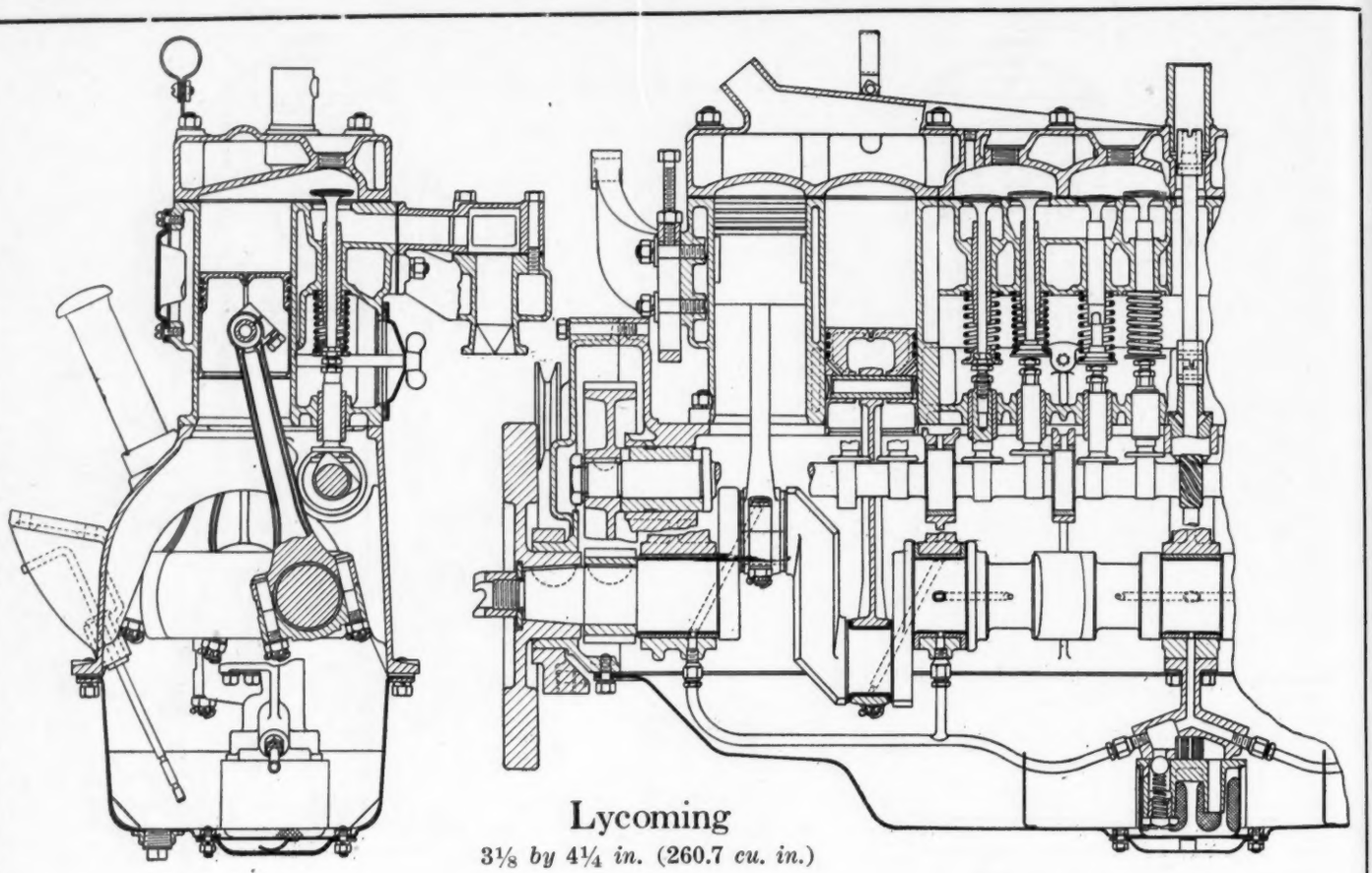
2⅞ *by* 5 *in.* (259.6 *cu. in.*)



Hansa-Lloyd

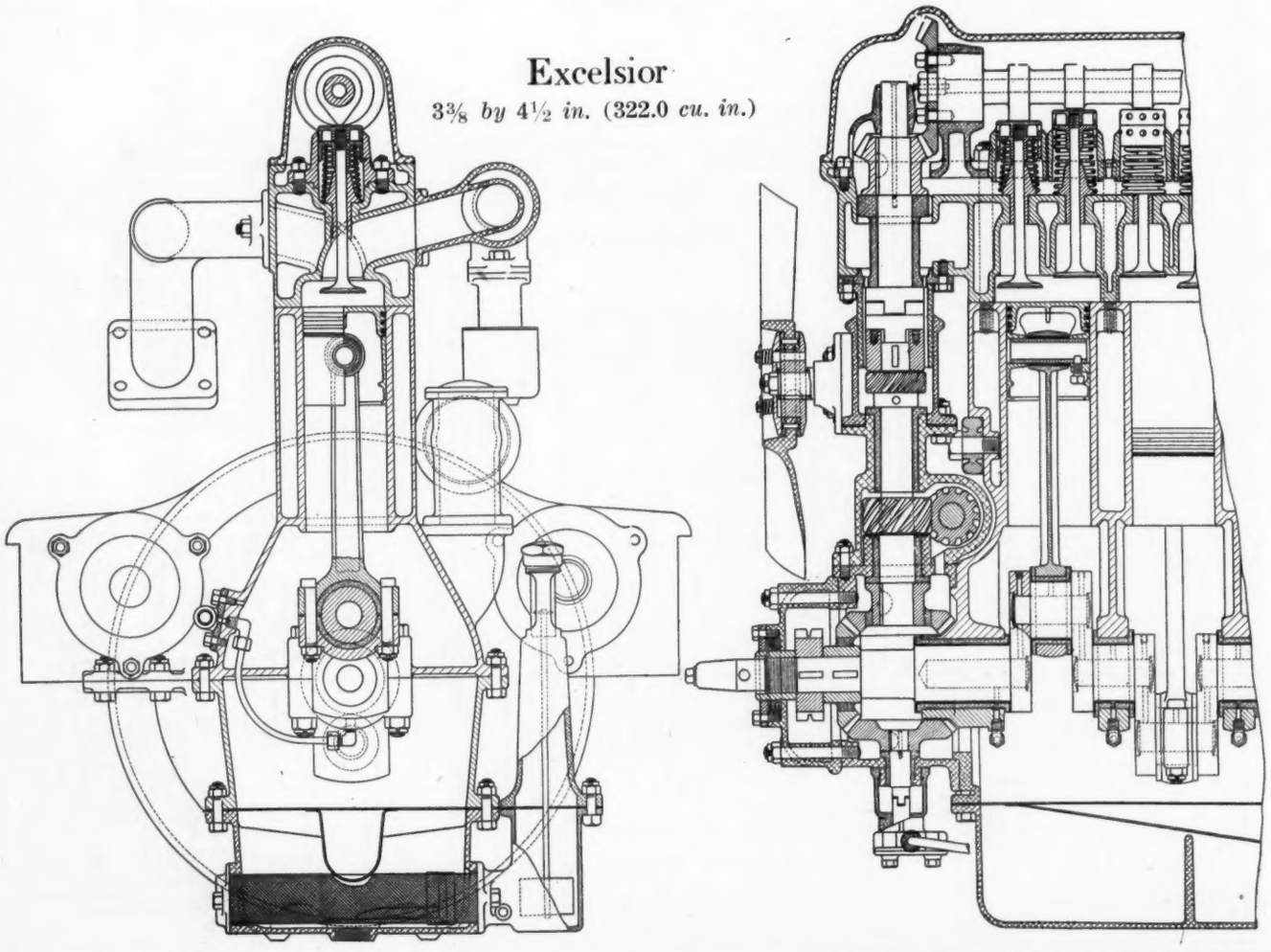
2 13/16 *by* 5 1/16 *in.* (240 *cu. in.*)





Lycoming

3⅛ *by* 4¼ *in.* (260.7 *cu. in.*)

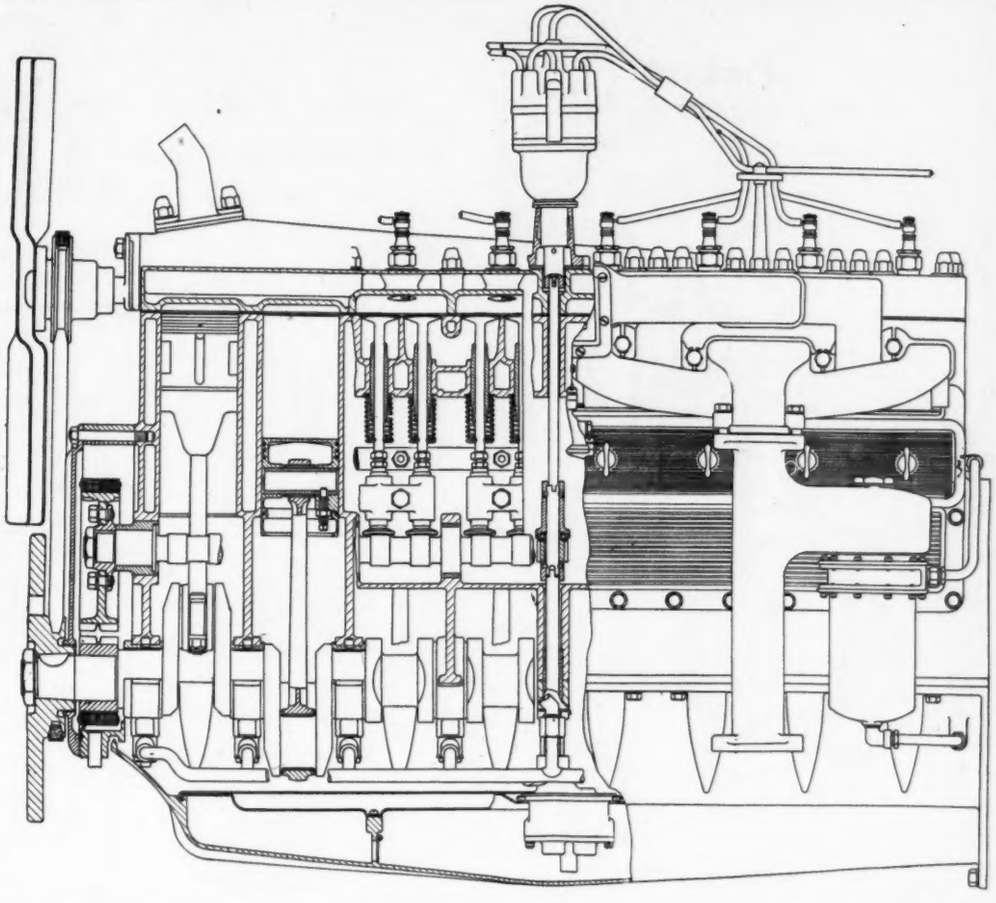


Excelsior

3⅜ *by* 4½ *in.* (322.0 *cu. in.*)

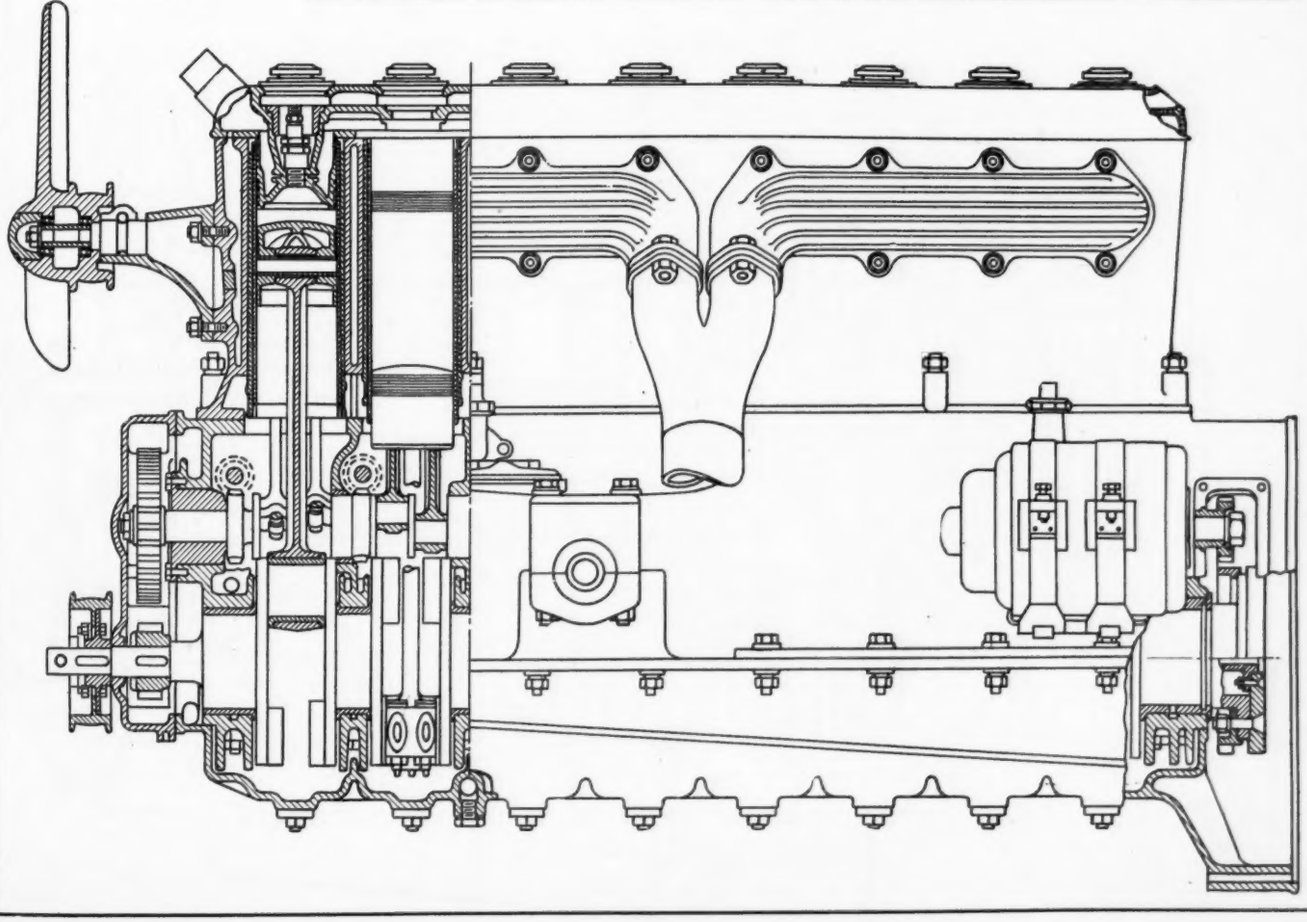
Rickenbacker

3 *by* 4¾ *in.* (268.6 *cu. in.*)



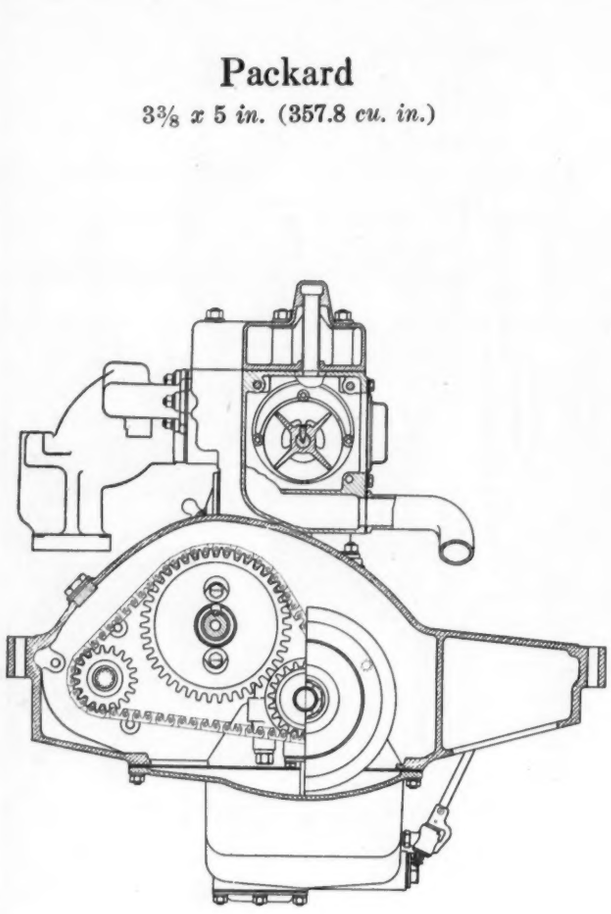
Panhard

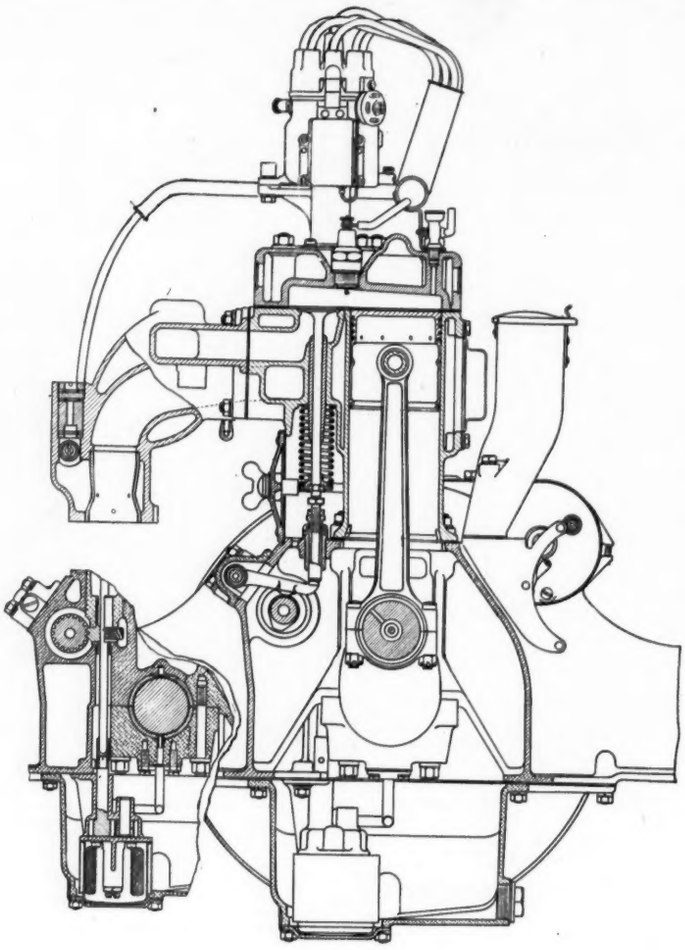
3 11/32 *by* 5½ *in.* (384 *cu. in.*)

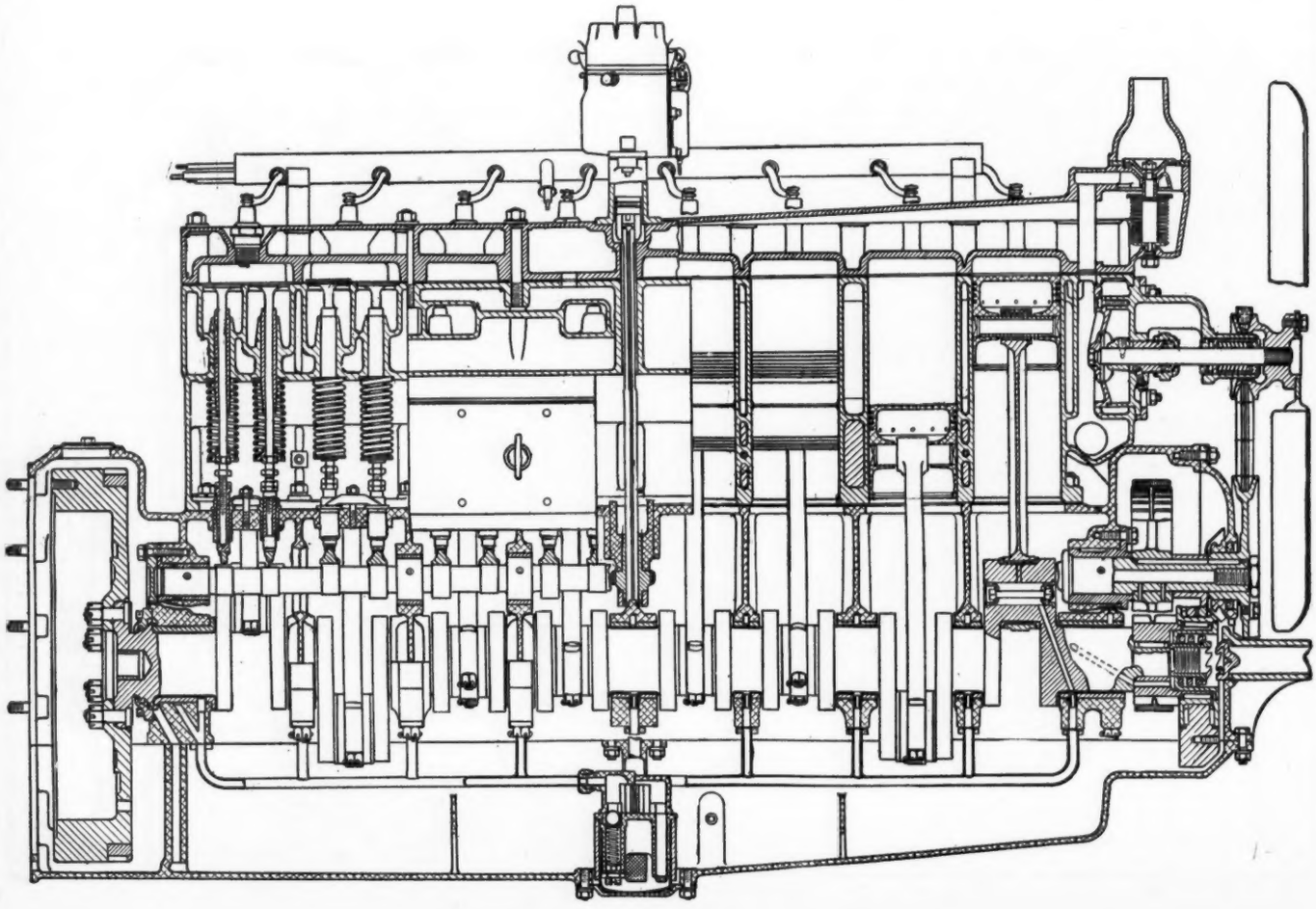


Packard

3⅜ *x* 5 *in.* (357.8 *cu. in.*)

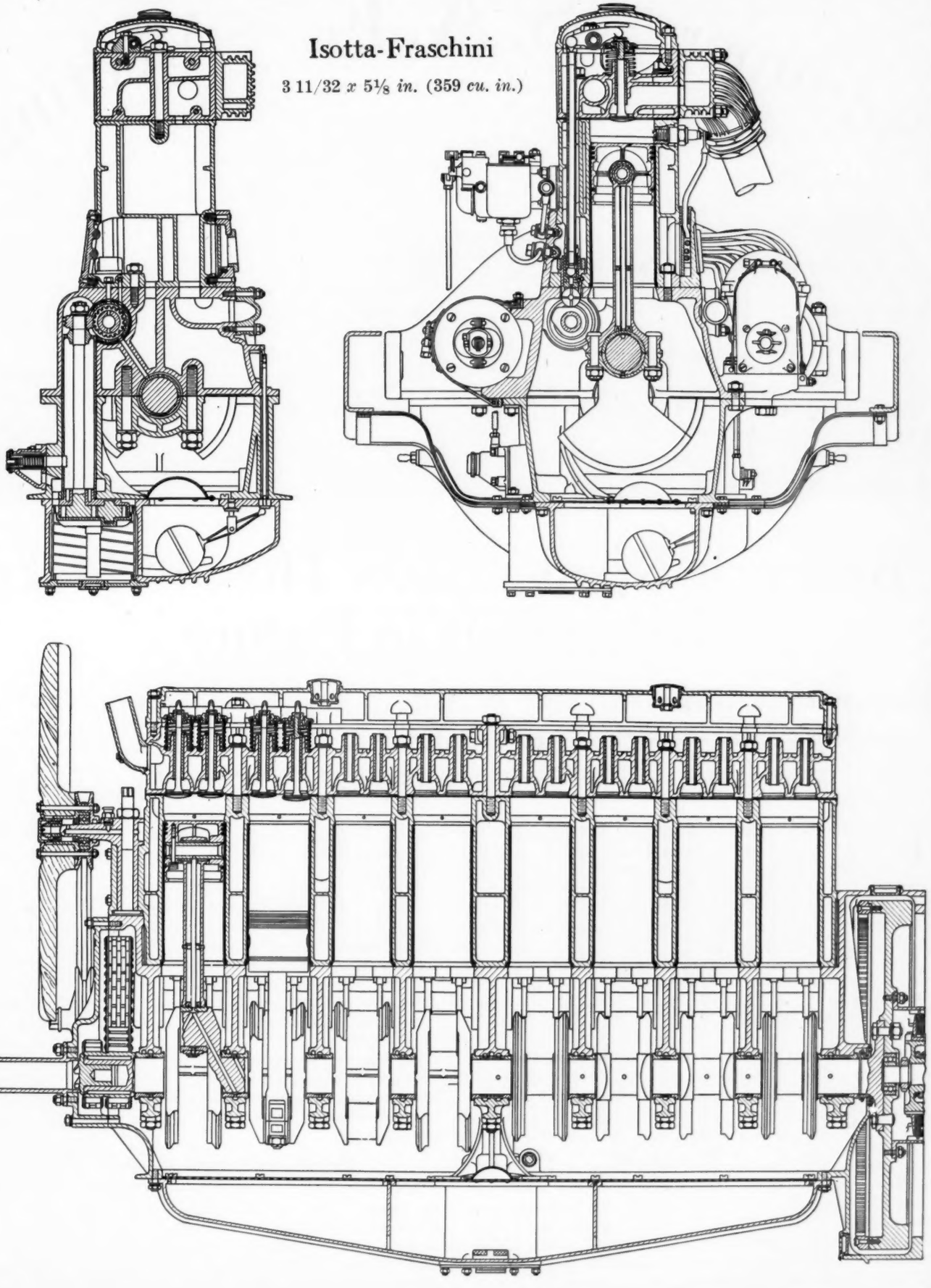






Isotta-Fraschini

3 11/32 *x* 5⅛ *in.* (359 *cu. in.*)



Summer S.A.E. Meeting

Research Results Show How to Make Better Cars in Future

Summer meeting of Society of Automotive Engineers proves that laboratory work is answering many practical queries. Harry L. Horning chosen as next president.

FURTHER research and detailed investigation are needed if automotive design work is to go forward as rapidly in the future as it has in the past. This was the chief idea to be derived from the various papers and discussions at the summer meeting of the Society of Automotive Engineers held in Spring Lake, N. J., June 24-27.

Harry L. Horning, managing director, Waukesha Motor Co., was chosen as the presidential nominee for 1925. Mr. Horning's selection was generally expected for some time previous to the announcement of the nominating committee because of his very active work for the S. A. E. over a period of years and because of his recognized abilities as an engineer and a leader of men. The other officers chosen by the nominating committee also were received with universally favorable comment. They were:

T. J. Litle, Jr., Ford Motor Co., Lincoln Division, first vice-president; H. D. Church, Chevrolet Motor Co., 2nd vice-president representing motor car engineering; O. B. Zimmerman, International Harvester Co., 2nd vice-president representing tractor engineering; P. G. Zimmerman, Aeromarine Plane & Motor Co., 2nd vice-president representing aeronautic engineering; C. F. Scott, General Electric Co., 2nd vice-president representing stationary internal combustion engineering.

New members of the council chosen were: C. H. Foster, Gabriel Mfg. Co.; O. M. Burkhardt, Pierce-Arrow Motor Car Co.; and E. P. Warner, Massachusetts Institute of Technology.

Whether the topic under consideration at this summer meeting was riding comfort, oil dilution, transmission design or air cleaners, it was evident from the differing views expressed that automotive engineering has reached a stage in its development where specific laboratory tests are required as a basis for future action. On this one point the trend of thinking seemed to be agreed, although considerable difference of opinion arose concerning many other items.

As a basis for researches of this kind it is necessary to develop testing apparatus which will provide accurate and adequate results and much of the time at the meeting was spent in discussion of research methods and interpretation of data.

Definitions Precede Improvements

It is easy to say, for example, that riding comfort should be improved, but it is another thing to get a generally acceptable definition of riding comfort and a means of measuring this abstract quality. But this is the difficult task before the automotive engineers and they are digging into it with a will. They seem determined to find out the finest details about every feature of motor vehicle design

and operation, particularly those which affect owner convenience and comfort to any material extent.

Engineers brought to the meeting the latest results from their laboratories and outlined for their fellow workers the progress of their researches. Neil MacCoull, A. Ludlow Clayden, R. L. Skinner and several others told of the results of their experiments in connection with various phases of the crankcase oil dilution problem. S. P. Hess, E. H. Lockwood and J. A. C. Warner brought in the latest returns about riding comfort studies, devoting a large part of their time to discussion of instrumentation. The transmission session consisted chiefly of descriptions of some new devices, while the air cleaner meeting involved both descriptions of products and discussions of air cleaner efficiency.

Attendance Falls Off

Attendance at the meeting was considerably less than last year and the topics under consideration had less popular appeal. There can be no question, however, that the research results presented at Spring Lake last week are of very real importance to the development of automotive engineering and that their fundamental significance far outweighs their immediate dramatic quality. The data presented, which are summarized in the following pages, are well worth the study necessary for their appreciation.

The number of people actually sitting in on the various sessions compared favorably with last year, despite the fact that the total attendance was smaller. More than 200 engineers were in the room for every technical meeting while the total was nearer to 300 in one or two instances. This general statement does not apply, of course, to the business and standards sessions, which drew their usual sub-quorum quota.

Two amendments to the constitution were proposed during the summer meeting, one designed to extend the membership qualifications so as to include engineers working in the operating and service division of the automotive business; the other designed to change the composition of the sections committee. Both were laid on the table in accordance with the requirements of the constitution and will be voted on at the next annual meeting.

The S. A. E. research committee met during the convention and laid plans for continuation of the investigations already under way on fuel research, riding qualities, truck transportation costs, safety code on brakes, and gear research. A proposal was made to take up research on carbon monoxide in exhaust gases, perhaps in collaboration with the Bureau of Mines, but no definite action was taken.

The Dayton Section of the S. A. E. announced that it will award annually a medal, known as the Wright Brothers' Medal, for the most meritorious contribution to the aeronautical science reported to them during the year. This medal is to commemorate the pioneer aeronautical achievements of the Wright Brothers. The award committee for 1925 consists of E. P. Warner, Massachusetts Institute of Technology and Henry M. Crane, president, Society of Automotive Engineers.

The sports furnished a lot of interesting competition despite the rain which marred the last two days of the meeting. All of the events were completed except the finals of the tennis singles which will be played off at a later date between Coker F. Clarkson and Norman G. Shidle.

The golf tournament was conducted on a medal play basis instead of by match play as in previous years and resulted in the crowning of a new champion, F. W. Davis, who carried off the honors with an 86. M. H. Cox was runner up with an 88. In the second flight Webb Jay came out ahead with a score of 94, being followed by Neil McMillan with 95. W. G. Whetherby carried off first place in the third flight by shooting 97, while J. W. White took second with a 99.

Cleveland Wins in Baseball

Cleveland Section won another leg on the intersectional base ball cup by defeating Detroit 9-2 in the finals, while R. S. Ellis had high net score in trapshooting. A. D. T. Libby won the horseshoe pitching contest and, paired with C. F. Gilcrist, took home the doubles prize as well.

Winners of the field events were:

50-yard dash—men under 30	Olney Jones
50-yard dash—men 30-40	Neil McMillan
50-yard dash—men over 40	T. V. Buckwalter
50-yard dash—boys under 15	Dan Foster
50-yard dash—men—novice	J. H. Shoemaker
50-yard dash—ladies	Miss M. J. Thacher
Fatman's race	T. V. Buckwalter
Three-legged race	L. C. Porter
Potato race—men	Neil McMillan
Potato race—ladies	Miss E. Tygert
Pogo race—men	Olney Jones

Henry M. Crane, president of the S. A. E.

Harry L. Horning, nominated to be president of the S. A. E. next year

Pogo race—ladies	Miss M. J. Thacher
Shot put	R. Abell
Standing broad jump—under 40	B. W. Brodt
Standing broad jump—over 40	F. G. Whittington
High jump	J. C. Talcott
Intersection relay	Detroit Section

Herbert Chase and Norman G. Shidle won the tennis doubles final from Coker F. Clarkson and Stanley E. Bates in three straight sets (6-2) (6-3) (6-2). Mrs. J. D. Cutter won the ladies tennis singles, defeating Mrs. Carl T. Klug in the finals.

The intersectional sports championship was won by the Metropolitan Section with a total score of 179, while Detroit was second with 93½ points.

Increase in Temperature Cuts Oil Dilution

Research results show how to minimize trouble. Specific phases of problem are being studied in great detail. Progress outlined.

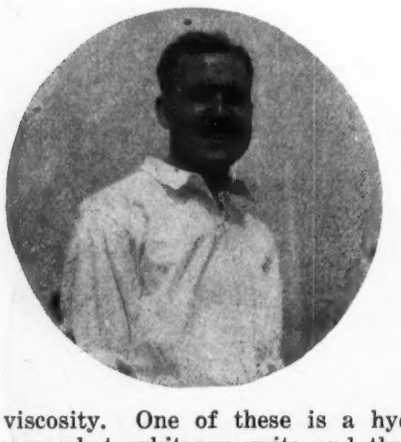
POWERPLANTS which run at too low temperatures give rise to certain difficulties which are much lessened or eliminated when the temperatures are increased above a certain point. This was one of the important facts brought to light in the sessions devoted to study of the cause of dilution of crankcase oil with fuel or with water condensed from products of combustion.

It appears that neither fuel nor water will enter the crankcase in quantities sufficient to cause serious injury if the cylinder and crankcase are maintained at suitable temperatures which are not difficult to attain under most service conditions.

Instead of using devices intended to remove oil diluents it would appear to be possible to prevent dilution by so designing the engine as to maintain higher temperatures than are frequently attained, especially in cold weather.

In the first paper presented at the oil dilution session, C. M. Larson of the Sinclair Oil Co. described efforts made to bring about more intelligent methods of determining when crankscase oil should be changed. He showed that the character of use rather than the distance the car runs between oil changes determines the amount of dilution so that it is not logical to change oil every so many miles.

In consequence some simple instruments have been developed to measure dilution by measuring gravity and viscosity. One of these is a hydrometer graduated in somewhat arbitrary units and the second a simple form of viscosimeter in which the difference in time for a sphere to fall through the undiluted and the diluted oil is determined.



J. O. Eisinger, Bureau of Standards, told of progress in fuel research during oil dilution session

While some of the data presented by Mr. Larson were questioned by various members, it appeared to be the sense of the meeting that it is necessary to do more than determine the amount of dilution, for the reason that sedimentation is in some cases more apt to cause trouble than dilution, and is especially serious in combination with dilution.

J. A. C. Warner of the S. A. E. Research Staff gave the results of a questionnaire concerning dilution which was sent to representative concerns in the industry. One point made in many replies is to the effect that carbureter chokes are used to excess and that there is need for education intended to prevent this abuse. Others drew attention to the effect of jacket water and air temperature, but there was difference of opinion in respect to the importance of ring and piston design and fit.

Dilution in excess of 15 per cent generally is considered dangerous. Recommendations as to the distance a car can run safely without changing oil vary widely but average around 500 miles in summer and 300 miles in winter, although some mention figures as high as 2500 and 1000 miles respectively. Among the improvements suggested to avoid or minimize dilution are: Better distribution, use of radiator shutters, thermostats, and rectifiers. It was generally agreed that consideration of sediment in combination with dilution is highly important.

Chairman T. J. Litle, Jr., called attention to the inaccessible oil drains on many engines and the practically universal lack of convenient means for obtaining samples of oil in order to determine whether or not it needs changing.

Neil MacCoull's paper on consumption and dilution of engine oils was the subject of much interesting discussion. This paper, an abstract of which appeared in these columns last week, described a series of tests made by the laboratory staff of the Texas Co., in which the consumption of engine oil and its dilution by fuel was studied.

Among the conclusions reached are the following: Dilution is approximately proportional to the fuel consumed and increases as the richness of the mixture is increased and as the throttle is opened. Oil consumption varies with the speed of the pump and not in proportion to the pressure, which increases almost as the square of the speed. Change in temperature of air entering the carbureter has little effect on dilution, but changes in temperature of crankcase have a marked effect. Power increases to some extent with increase in cylinder water temperature.

In reply to various questions Mr. MacCoull stated that dilution decreases with increase in jacket water temperature. Particles of foreign matter in the oil are apt to be more serious than dilution. Heating of crankcase is highly desirable if it can be accomplished without too much complication.

Otto M. Burkhardt of the Pierce-Arrow Co. said that the formation of sludge in the crankcase, consisting chiefly of silicious and metallic particles, is among the

serious problems to be met. J. O. Eisinger of the Bureau of Standards expressed the view that dilution is not nearly so important as dirt in the oil and that more rapid circulation of the oil tends to decrease dilution.

Effect of Heating Inlet Manifold

O. C. Berry of the Wheeler-Schebler Carbureter Co. drew attention to the importance of rapidly heating the inlet manifold after the car is started. He believes in the use of a very hot spot of relatively small area just above the carbureter and stated that such a spot can be employed without much heating of the total charge.

Another member stated that excellent results and freedom from dilution had been attained by heating the fuel to 100 deg. Fahr. while still in the liquid state and before it left the carbureter.

Mr. MacCoull drew attention to the fact that there is a wide difference in the amount of oil fed through the bearings in various engines. Some data he gave indicate that there are variations from 0.5 to 10.0 cu. in. per revolution of the crankshaft. He said that in German Mercedes engines the amount of oil thrown on the cylinder walls is only one-thirteenth as much as is used in many American engines.

A. Ludlow Clayden presented an interesting paper on water in crankcase oils which will be printed in full in the next issue of AUTOMOTIVE INDUSTRIES.

In answer to questions Mr. Clayden said that humidity was not constant during the tests reported in his paper, but that it had been shown that changes in humidity had but little effect on the results obtained. Oil which enters the crankcase is almost entirely from products of combustion. Agitation is important to free an oil from water. Test results reported are minimum rather than maximum.

F. E. Moskovics read a brief paper pointing out certain advantages claimed for castor oil as a lubricant and laying stress on its relative freedom from the evil effects of fuel dilution. Robert E. Wilson of the Standard Oil Co. of Indiana stated that castor oil has about two-thirds to three-quarters the affinity for fuel that ordinary mineral oils have, so that its effect when mixed with mineral oils in respect to preventing or decreasing the effects of dilution are practically nil.

Results Check with Theory

In commenting on the Clayden paper, Dr. Dickinson said that the results appeared to check with elementary theory and that an engine which is operated with a wall temperature above the dew point of water will be free from water in the crankcase, as Clayden indicates. Much the same will be true in reference to fuel dilution if the engine is maintained at a temperature above the dew point of the fuel.

R. W. A. Brewer said that samples of crankcase oil have shown as high as 34 per cent water content, so that water in the crankcase becomes a serious problem in some cases. He pointed out also that it is desirable to use an oil of as low viscosity as possible in order to decrease friction losses. With an oil of low viscosity, a small percentage of vegetable oil containing a fatty acid, such as castor oil, is desirable.

B. B. Bachman, chief engineer of the Autocar Co., cited the fact that many years ago when fuel was much more volatile than today, roads were more dusty and there was, in all probability, more dust entering the cylinder than on present practically dustless roads. On the other hand, there was no noticeable dilution of the oil with fuel, so that serious difficulties were avoided. Later speakers stressed the point that it is the combination of dilution and dust which causes most serious difficulty. With either one alone wear is much less rapid.

Mr. Bachman mildly criticised the Clayden paper for giving conclusions without giving a complete record of the data on which the conclusions are based. He said that he had checked up the dilution in certain trucks and found it to be considerably greater in the case of trucks making short runs with long periods of idling than with trucks doing long distance hauling, though it amounted to as much as 20 per cent even in the latter case.

J. H. Hunt of the General Motors Research Corp. presented a paper written by H. C. Mougey of the same company, in the absence of the author. A digest of this same paper appeared in these columns under date of May 1.

C. M. Larson read a paper on "Better Crankcase Draining Service"

Neil MacCoull gave the results of oil dilution tests made by the Texas Co.

S. P. Hess talked on spring design as related to riding comfort

It dealt with the subject of corrosion in engines caused by the formation of sulphuric or sulphurous acid in the crankcase due to the presence of an excessive amount of sulphur in the fuel, in combination with water condensed from the products of combustion.

Exclusion of Water Prevents Corrosion

It was pointed out that if means are taken for preventing the water from reaching the crankcase, little if any corrosion occurs for the reason that the acids in question are not formed unless water is present.

Thomas Midgley, Jr., also of the General Motors Research Corp., said that he just had come from a meeting of the American Society for Testing Materials and that it had been agreed there to abandon the so-called "lamp" method for determining the percentage of sulphur in fuel in favor of another method which gives more reliable results and which will tend to prohibit the use of motor fuels which are excessively high in sulphur content.

Mr. MacCoull confirmed the statement that trouble from corrosion is eliminated if steps are taken to prevent water from reaching the crankcase.

Mr. Clayden suggested that the Fuel and Lubricants Division of the Standards Committee consider the preparation of a standard method for determining the percentage of dilution in lubricating oil in order to prevent the confusion which now results from following methods which differ widely.

George A. Round found it impossible to be present at the meeting, hence the paper giving microphotographs of contaminated oil, which he was to have presented, was omitted.

The evening session, devoted to dilution, was given over to papers by R. L. Skinner on the rectification of crankcase oil, and by J. O. Eisinger, who made a progress report on the cooperative fuel research being conducted by the Bureau of Standards in conjunction with the S.A.E., the N. A. C. C. and the American Petroleum Institute.

Mr. Skinner's paper consisted chiefly of a description of the oil rectifier which he has developed and which was fully described in these columns in the issue of May 15. An abstract of additional material given in his paper appeared in AUTOMOTIVE INDUSTRIES for June 26. Mr. Skinner contends that dilution is the primary cause of wear and says that dust alone is not apt to cause wear unless the viscosity of the oil is decreased by dilution.

In answer to various questions concerning the rectifier Mr. Skinner said that the oil passing through seldom reaches a temperature in excess of 250 deg Fahr. No trouble from clogging of small orifices with sludge or foreign matter has been encountered because air and vapor continually are circulated through the small openings to the cylinder. No trouble has been encountered due to operation at temperatures even as low as 30 deg. Fahr. below zero.

Ralph L. Skinner, Skinner Automotive Devices, Inc., gave a history of the development of the oil rectifier

Messrs. W. G. Wall and L. M. Stellman, who have had considerable experience with the rectifier spoke well concerning its performance, the latter stating that he yet had to find any faults with the device and that noticeable decrease in wear had resulted from its use.

Asked concerning the effect on distribution and dilution of the use of a supercharger, F. S. Duesenberg said that the supercharger used in his racing car had greatly improved the distribution and may result in less dilution. He was much surprised to find six of the eight exhaust valves in the engine which won the recent Indianapolis race bright and clean at the finish.

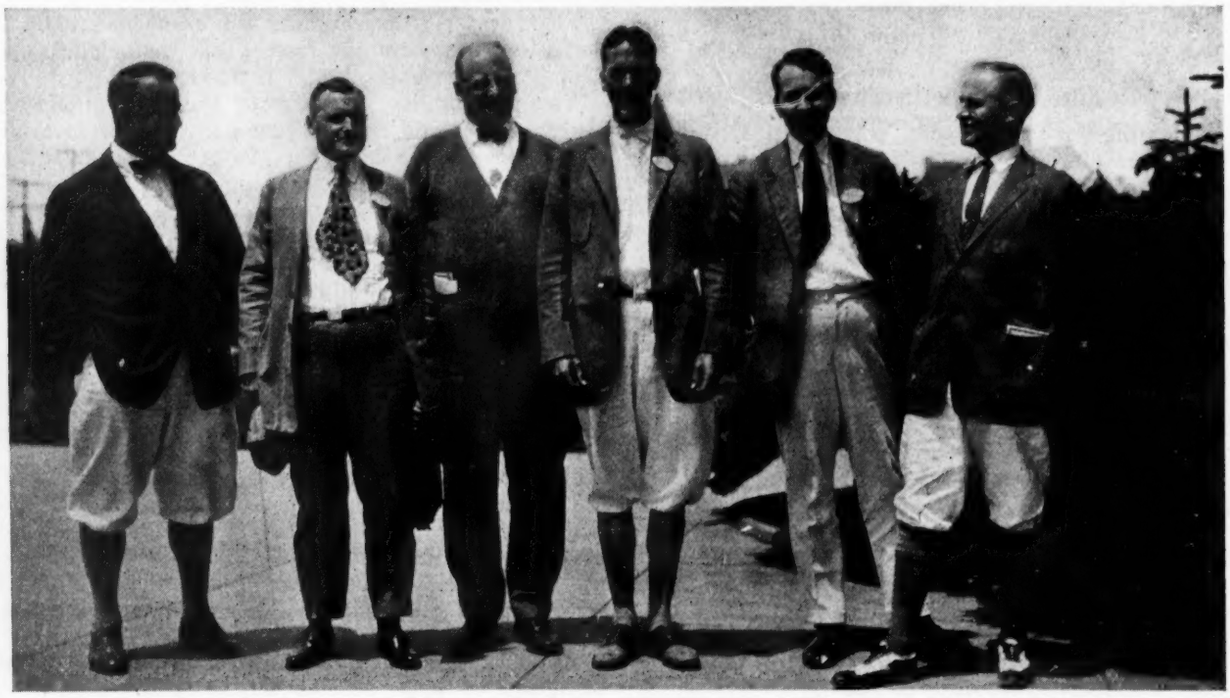
Research a Practical Tool

Mr. Crane drew attention to the "fine set of tools" which the society now has to work with as a result of research activity and mentioned the fact that tests to date indicate that piston and ring design appear to have much less effect upon the results obtained than was expected.

Mr. Berry asked whether thermostatic control of jacket water temperature tends to prevent dilution and Mr. Eisinger replied that the tests showed that it will do so if the water is maintained above a certain critical temperature. In reply to a question by Mr. Wilson, Dr. Dickinson said that data secured in the fuel research show that heat applied to the charge entering the engine appears to have but little effect on dilution. It is his view that the oil film on the cylinder wall is in such intimate contact with the wall that it is capable of taking heat from the wall rapidly and so maintaining a rate of fuel evaporation which prevents the dilution from exceeding a certain amount dependent upon the temperature of the jacket water, the amount being less as the temperature is increased.

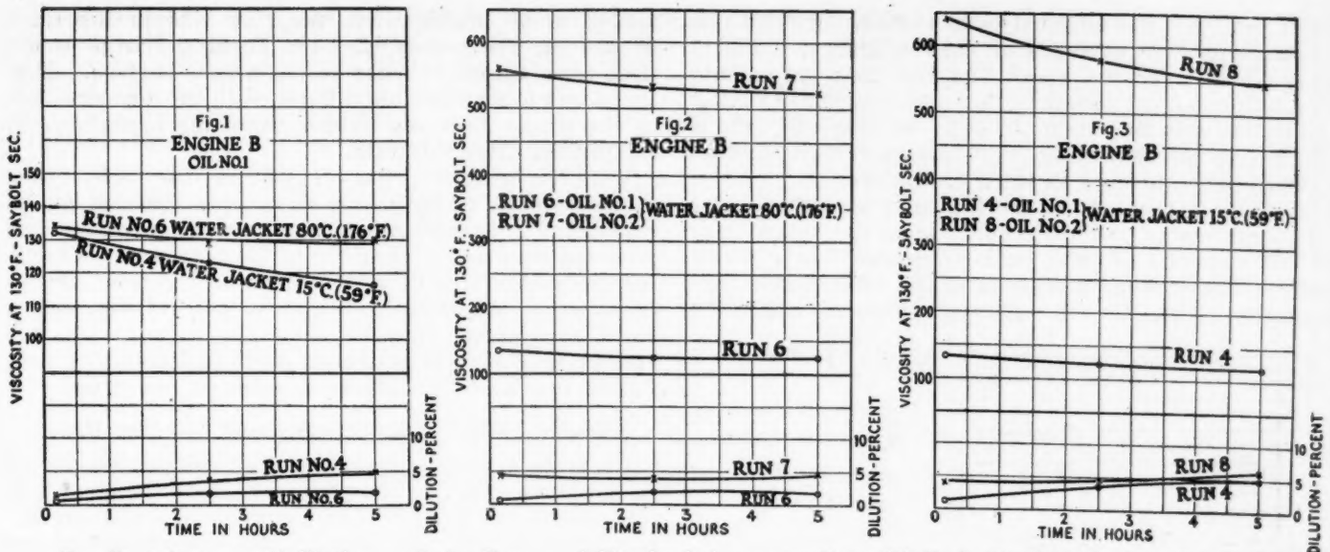
C. P. Grimes mentioned tests in the cold room in which it had been found that cranking an engine with the oil very cold soon had caused the oil to leave the piston walls, and caused the engine to squeak when cranking, which became very difficult, when continued. Adding a few drops of fluid oil through the spark plug openings immediately caused the engine to turn over easily for a few revolutions after which the hard turning again became apparent. This, he said, shows that oil in the cylinder passes very quickly into the crankcase.

T. J. Litle, Jr., mentioned tests made in cold weather in which it had been found that cranking an engine for



SPORTS COMMITTEE

A. K. Brumbaugh, Autocar Co. A. D. T. Libby, Splitdorf Electrical Co. A. C. Bergmann, C. G. Spring & Bumper Co., chairman of sports committee. Gordon Brown, Bakelite Corp. E. P. Warner, Massachusetts Institute of Technology. F. A. Cornell, C. G. Spring Co. of Delaware



Result of tests on oil dilution made by Bureau of Standards in cooperation with S. A. E., N. A. C. C. and A. P. I.

fifteen seconds, as often happens in starting, had resulted in a full half pint of fuel entering the crankcase and that much more enters during the warming up period. One member said that he had developed an apparatus which prevented this dilution during starting and had been able to operate a Knight engined car 20,000 miles during two years without draining the crankcase.

An abstract of J. O. Eisinger's report on the cooperative fuel research follows:

Research Shows Factors Governing Oil Dilution

CONSIDERABLE progress has been made in the Cooperative Fuel Research since the last report was presented in January, 1924. It will be recalled that the chief obstacle to the use of fuels of low volatility was shown to be the high rates of crankcase oil dilution which resulted. This led the Steering Committee of the cooperating organizations to recommend that further efforts be directed to a study of the factors affecting crankcase dilution.

In a report presented to this society a year ago, June, 1923, S. M. Lee showed that the temperature of the jacket water exerted a marked influence on the rate of dilution; more dilution occurring when operating with cold jacket water than when operating with hot. It appeared logical to endeavor to ascertain why this influence should exist.

Three explanations suggested themselves. Perhaps the most obvious explanation was that this influence was due to changes in the rate at which the diluent was eliminated from the oil upon the cylinder wall, this rate being dependent upon the temperature of the jacket water. Reluctance in accepting this explanation can be ascribed to the fact that the temperature of the initial point of diluent recovered from crankcase oil ordinarily is much higher than the highest jacket water temperature employed.

The second explanation was suggested by some measurements of piston temperature made by Jehle and Jardin, who found that when there was a change in jacket water temperature there was a similar but very much greater change in piston head temperature. If then the temperature of the piston head is intimately related to the rate of dilution, it follows that a material change in its temperature such as might result from a change in jacket water temperature, would change the rate of dilution.

The third explanation relates to the viscosity of the oil upon the cylinder walls. This viscosity changes with each change of jacket temperature. It was not difficult to suppose that as the oil became more viscous, it might be less completely distributed around the piston and hence be less effective in preventing the passage of fuel from the combustion chamber to the crankcase.

The engine selected for previous work was chosen solely because it was of a type in widespread use. For the work here reported this qualification seemed less essential than that the engine should be of such rugged construction as to require overhaul at only infrequent intervals. The engine chosen termed engine B, was a four-cylinder truck engine of 4¾-in. bore and 6-in. stroke. Reference is also made to engine A, which was a four-cylinder 3 x 4¼-in. overhead valve type. For the most part the use of engine A has been restricted to the obtaining of preliminary and qualitative measurements.

The method of test was similar to that described in previous reports. After the engine had been operated until the desired temperatures had been attained and the necessary adjustments made, it was flushed with a definite quantity of the oil to be used in the test. This flushing was accomplished by driving the engine for 5 min. by the dynamometer, after which the engine was again drained. The engine then was charged with new oil and the test started. In each run the power and mixture ratio were adjusted to give maximum power. For convenience engine B was operated in most instances at a speed of 1000 r.p.m. and about one-third load, while engine A was operated at 1100 r.p.m. and about two-thirds load.

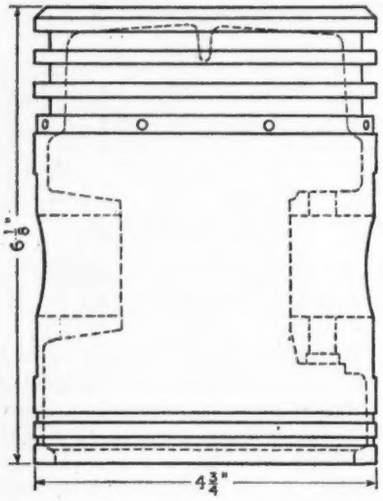
Oil Samples Tested

Oil samples (16 oz.) were taken 10 min., 2½ hr. and 5 hr. after starting. Approximately the same amount of dilution was found in samples drained from the crankcase at the beginning of the run as at the end of the 10-min. period, showing that there was no excessively high rate of dilution during this time. Measurements of dilution have been plotted as they were obtained with no corrections applied for fuel believed to be in oil remaining in engine at start of test, in spite of draining.

Before undertaking to find which was the correct explanation for the influence of jacket water temperature

upon dilution it was obviously wise to make sure that this engine also gave evidence of such influence. Fig. 1 shows such to be the case. The fact that the amount of dilution is much less than that obtained under similar conditions with the engine used in the previous tests is significant as indicating that design characteristics have no little influence on rates of dilution.

To find whether or not the influence of jacket water temperature was due to its effect upon the viscosity of the oil upon the cylinder walls it appeared only necessary to make comparative tests at the same jacket temperature, using oils of radically different viscosities.



Piston used in engine employed in dilution tests described in Eisinger paper

The oils selected were designated No. 1 and No. 2 and had the following characterstics:

Oil No.	Viscosity at 130 Deg. F.	Viscosity at 210 Deg. F.	Flash Deg. F.	Fire Deg. F.	Sp. Gr. at 60 Deg. F.
1	141	52	395	460	0.899
2	705	128	515	585	0.892

Fig. 2 shows the results obtained with hot jacket water and Fig. 3 those obtained with cold. It is unfortunate that oil No. 2 should have contained some constituents more volatile than the heavy ends of the gasoline used, as these undoubtedly are responsible for the high percentages of apparent dilution at the end of the 10-min. period and to some extent should be held accountable for the fact that the increase in dilution during the 5-hr. period was so small. In spite of this fact when one observes the enormous difference between the viscosities of the two oils he cannot help but be convinced that the two oils would have shown more radical differences in dilution were the effect of jacket water temperature due to its influence on the viscosity of the oil upon the cylinder walls.

Effect of Temperature Change of Piston Head

To ascertain the effect of a change in the temperature of the piston head upon the rate of dilution it was desired to make tests with the piston head at two different temperatures. To accomplish this runs were made using but one piston ring, the ring in one instance being in the top groove of the piston, in the other instance being in the third groove.

Tests have shown that the greater proportion of heat dissipation from the piston to the cylinder walls takes place through the piston rings. With the ring in the third groove there would be no opportunity for any considerable amount of heat dissipation from the section above the ring. Hence this section would be at a considerably higher temperature than with the ring in the upper groove.

The temperature of the piston head might also be expected to be higher when the ring was in the third groove for the reason that the burning charge would then have access to more of the piston surface. That there was a considerable difference in the temperatures of the piston head was evident from the appearance of the pistons after the tests.

With the oil relief holes plugged, as they were in this comparison, all of the piston skirt below the ring can be considered to contribute to the prevention of leakage from the combustion chamber to the crankcase. Changing the piston ring from the upper to the third groove changes the effective seal against gas leakage, but a small percentage. Results show the influence of this change in piston head temperature to have been negligible insofar as crankcase dilution is concerned.

Water Jacket Temperature and Dilution Rate

From the foregoing it appears that neither the change in the temperature of the piston head nor the change in the viscosity of the oil upon the cylinder walls can account for the relation between the temperature of the jacket water and the rate of dilution. It appears, therefore, that the explanation must be in the effect that a change in the temperature of the oil film upon the cylinder walls has upon the rate at which the diluent is added to or eliminated from that film.

In this connection the results of a test with engine A are illuminating. This engine was supplied with an oil which had been prepared by mixing 30 per cent kerosene with 70 per cent of oil No. 1. The engine was driven by a motor for 5 hr., no fuel being supplied and no combustion occurring in the cylinders. The jacket water temperature was 100 deg. Fahr. and the oil temperature 102 deg. Fahr. Although the kerosene was much less volatile than the diluent, which ordinarily is recovered from a crankcase oil, there was a decrease in dilution of 7 per cent during the 5-hr. period.

It seems desirable at this time to direct attention to some factors other than those related to jacket water temperature, which are being investigated with reference to their influence upon dilution, even though it may be necessary to defer the drawing of conclusions as to the extent of this influence until later. These include (1) piston seal, (2) quantity of oil, (3) rate of oil circulation, (4) amount of cylinder surfacce exposed to charge, etc. Under the conditions of operation in these tests (1/3 load at 1000 r.p.m.) dilution was not appreciably greater when using only one piston ring than when using all three.

That percentage of dilution is affected by the quantity of oil in the system is quite generally appreciated. Obviously if the amount of oil to which the diluent is added is reduced and the rate at which the diluent is added is not changed then the percentage of dilution at the end of a given period will have been increased. However, as the quantity of oil in the system is reduced the rate at which it circulates, that is to say the number of times the whole charge of oil passes through the system in unit time, increases. Tests indicate that this may increase the rate at which the diluent is eliminated from the oil.

It appears from the results obtained thus far that a considerable proportion of the dilution takes place as follows: As the piston travels downward on the suction stroke, liquid fuel is collected by, or vaporized fuel is condensed and collected by, the oil film on the cylinder walls. Some of this film eventually becomes scraped from the cylinder wall and falls into the crankcase. If this condition exists one would expect the amount of dilution to be dependent upon the area of exposed surface. Time of exposure may also be important.

These influences are linked with bore-stroke ratio, piston speed, etc., and are mentioned as being typical of those which must be evaluated before the dilution to be expected with one type of engine can be estimated from measurements made with another.

It has been shown that in the engine used in this test as in the one used in previous tests the temperature of the jacket water has a marked influence upon the rate of dilution. This difference does not appear to be due to the change in the viscosity of the oil upon the cylinder walls or to a change in piston head temperature, but rather to the difference in the rate at which the diluent is added to or eliminated from the oil film. It has been shown that under certain circumstances the diluent is eliminated at a fairly rapid rate and hence that an equilibrium condition may be reached at which the rate of elimination balances the rate at which diluent is added.

Means Sought to Increase Riding Comfort

Proper relation between tire pressure and spring stiffness is essential. New instruments devised to measure riding qualities.

INTER-RELATION between balloon tires and spring design was one of the important points discussed in the session devoted to riding comfort. Considerable difference of opinion developed as to whether the springs used with balloon tires should be stiffer or more flexible than those used with high pressure tires, but it was generally agreed that modifications in spring design are

E. H. Lockwood described tests made to determine riding qualities

necessary to secure the best results when balloon tires are used.

In this connection James E. Hale of Firestone said that his concern is making experiments with a view to learning what the periodicity of balloon tires may be. Data thus far secured indicate that the lower the air pressure and the larger the tire section, the lower is the frequency.

The consensus of opinion seems to be that it is necessary to insure a certain relation between tire pressure and spring stiffness in order to obtain satisfactory riding characteristics, but just what this relation should be is a matter which will require much study.

Mr. Hale attributes much of the trouble from shimmy with balloon tires to incorrect layout of draglink in reference to springs, and says that the shimmy is not dependent upon tire size or rim width. Variations in pressure which change the periodicity may bring about shimmying with high pressure tires as well as with balloon tires if the same relatively low pressure is employed in each.

In opening the riding comfort session, H. M. Crane said that the subject to be dealt with would relate to increasing the life of the passengers, while later sessions would deal with factors which determine the life of the vehicle. He added that there is an infinite amount of indefinite discussion in relation to riding comfort, largely because of the lack of a yardstick for measuring riding qualities. At present such measurements as are made are dependent upon the personal judgment of individuals, which judgment often is warped by the state of mind of the individual.

Referring in particular to the Hess paper, which discussed spring design, Mr. Crane expressed the view that the front springs of cars often are too stiff. Periods as low as 100 per min. are desirable if suitable rebound checks are employed. He showed further that interleaf friction has a distinct bearing on riding characteristics, especially when high unit pressures are present due to bearing on high spots on the unfinished spring surfaces. A multiplicity of thin leaves has a tendency to decrease the friction on each surface.

Walter C. Keys of Gabriel Snubber Sales & Service Co. said that not only should each chassis receive separate study in securing good riding qualities, but that the springs for each body model should be considered likewise.

T. J. Litle of the Ford Motor Co., Lincoln Division, expressed a preference for many tapered leaves in the case of high grade cars, and a suitable oil film between such leaves. The oil, he believes, helps to insulate the

L. B. Kimball collaborated with Professor Lockwood in the preparation of his paper on riding qualities

chassis against transmission of shocks from the road.

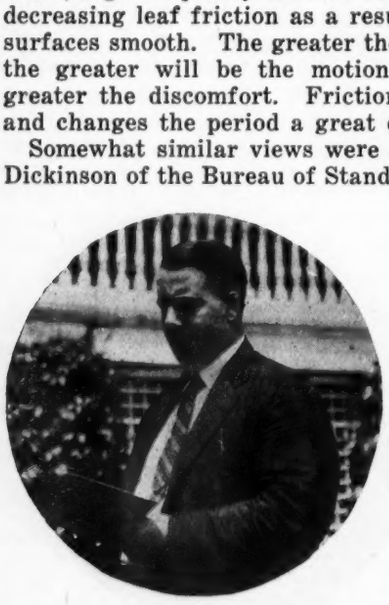
Otto M. Burkhardt of Pierce Arrow said that he has been unable to secure information from spring makers on the subject of interleaf friction or to find out from them how performance is influenced by such friction. The period of the spring is most important after all, he said, but much advantage is lost if interleaf friction is high.

Two past presidents talk over the affairs of the Society. Col. H. W. Alden, Timken-Detroit Axle Co., and B. B. Bachman, Autocar Co.

George Pennington gave it as his view that the softer springs absorb the greater shock, but that the car manufacturer must fit a spring which is stiff enough to give service under the worst driving conditions. Such a spring, of course, is not as comfortable as one which would give best riding on smooth roads. Damping is desirable but should be done by a device intended for this purpose and not by interleaf friction. Mr. Hess, on the other hand, expressed the view that interleaf friction helps riding qualities and tends toward a slower period.

F. C. Mock of the Stromberg Motor Devices Co. cited experiments which he made recently in which he has improved riding qualities and reduced the transmittal of small, high-frequency tremors from the road surface by decreasing leaf friction as a result of grinding the leaf surfaces smooth. The greater the friction in the spring, the greater will be the motion of the body and the greater the discomfort. Friction lowers the amplitude and changes the period a great deal.

Somewhat similar views were expressed by Dr. H. C. Dickinson of the Bureau of Standards, who said that polished leaves and lubrication tend to improve riding qualities. Friction does not affect period, however, but does affect amplitude. Rough tests made at the Bureau indicate that amplitudes as small as 0.001 in. at the rate of 500 per minute are decidedly disagreeable and that such vibrations are transmitted through seat cushions and often are felt as a result of driving over roads with small inequalities. Friction may produce vibrations of this character.



J. A. C. Warner, assistant research manager, S. A. E., presented an analysis of the riding quality problem at the session of riding comfort

Mr. Hess expressed the view that it is a good thing to lubricate the spring provided an auxiliary damping device is employed.

H. M. Crane said that the resiliency of the tire is an important element affecting riding qualities. Damping in some form is highly desirable. Another member called attention to the fact that certain damping devices give poor riding qualities on comparatively smooth roads.

Joseph A. Anglada mentioned the use of helical springs on some of the older types of passenger cars and said they gave good riding qualities at moderate speeds when suitable shock absorbers were employed. He suggested the use of such springs in certain tests as a means for eliminating the damping effect of friction.

A number of speakers, including Mr. Crane, mentioned the fact that ideas as to what constitute good riding qualities differ. No one knows certainly whether variations in period or acceleration are more important. High-period lateral vibrations, which are present in nearly all cars, sometimes become very distressing.

In the paper by Prof. E. H. Lockwood, an abstract of which was printed in these columns last week, there was given a description of a sort of integrating vertical accelerometer which has been used by him for making comparative tests of riding comfort. These tests show that balloon tires are very effective in minimizing vertical accelerations but that shock absorbers do not always improve riding qualities at low speeds. Mr. Crane made the comment that Professor Lockwood's tests certainly have a qualitative if not a quantitative value.

Photographic Tests of Riding Qualities

Prof. E. P. Warner described tests which he had conducted by photographing the paths transcribed by lights mounted respectively on the axle, and body of a car and the shoulder of a passenger riding in the car. In some of these tests it was found that the period of oscillation of the body was as much as three times as long as that of the axle. Violent pitching was indicated in nearly every case by the path transcribed by a light mounted on the radiator.

Walter C. Keys criticized the methods used by Professor Lockwood in that they do not give consideration to the effect on the passenger, but show rather the motion imparted to the body of the vehicle. In this connection he emphasized the need for good cushions and seat backs and commented favorably on a construction used in the Chrysler car in which the seat back is so arranged as to move up and down with the cushion instead of polishing the back of the passenger.

He added that a period of about 100 vibrations per minute is a desirable period for the seat cushion when best riding conditions are desired. A soft cushion is not necessarily the best from a riding standpoint. It is desirable not to have too thick a pad on the cushion and not to tie the upper ends of the cushion springs together too securely. To avoid difficulties, after production has started it is highly desirable to test the springs in the car on the road before going into production on a certain type of seat cushion.

Some speakers called attention to the difficulties involved in measuring and interpreting the results obtained by recording seismographs. Doubt was expressed if any one instrument will give a true measure of riding qualities.

In the paper by J. A. C. Warner, assistant research manager, S. A. E., there was given a general summary of the methods used for measuring riding comfort and descriptions of the instruments employed for this purpose. The more important of these instruments already have been described in these columns.

Mr. Warner said that it is necessary first to learn what

factors determine riding comfort, second, how to study these factors, and third, how to apply the results, once they are obtained. He expressed the view that a car designed for passenger comfort also will be apt to prove durable because of the cushioning from road shocks.

He stated that it is impossible at present to determine what the records obtained in riding comfort tests made to date mean in terms of riding comfort. This is largely because of a lack of information concerning the physiological and psychological effect of forces applied to the passenger. It is necessary not only to determine the forces acting but to know how they affect the individual. To this end, he said, the society is planning to cooperate with the American Medical Association in tests intended to measure the effect on individuals of various conditions such as are encountered in riding in passenger cars.

Mr. Hale's remarks on the effect of balloon tires on riding comfort included the following in addition to other items mentioned above: Decreasing the weight on the front axle tends to reduce shimmy. Tests on the periodicity of axle vibrations caused by jacking up the wheel and dropping it 2 in. showed 1.95 cycles per second for the spring as compared to about double this number for the tires. In this connection Mr. Crane called attention to the added weight on the front axle resulting from the use of front wheel brakes.

Dr. Dickinson stated that investigations made at the Bureau of Standards showed that the load-deformation curve of an ordinary tire is approximately a straight line. Discussing spring design as related to riding comfort, E. P. Hess, assistant manager, spring department, Detroit Steel Products Co., said in part:

Design Should Provide Comfort for Car User

EVEN when all mechanical means have been taken to obtain good riding quality for a car, there still remains the human or psychological element and the fact that some particular motion of a car may be decidedly objectionable to one person and yet be unnoticed by another. The tendency of many people not to relax when riding also induces fatigue, even in cars in which every precaution has been taken to provide riding comfort. Care must be taken to shape the backs of seats to provide for the passengers' comfort.

Experience has taught us that, in the study of riding comfort, each design of motor car must be considered individually. Certain variables are present in each instance and their influence upon spring-suspension is given below.

(1) The semi-elliptic and the cantilever types, either semi-elliptic or quarter-elliptic, are the two in general use.

(2) Length and width regulate the flexibility that can be obtained with stresses conducive to long life.

(3) Sprung and unsprung weights determine the flexibility and influence the presence of rebound.

(4) A rigid frame-construction requires more flexible springs because the frame has practically no "give" to road shocks.

E. P. Warner gave the results of recent riding comfort tests

(5) Wheelbase influences the flexibility to provide for balance between front and rear springs.

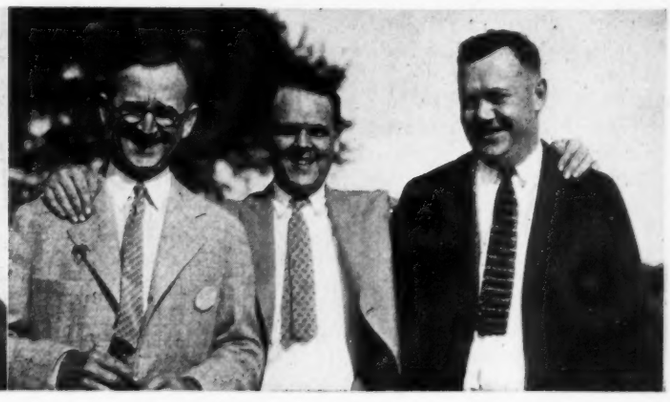
(6) The kind of material regulates the flexibility that can be obtained with stresses conducive to long life.

Shock absorbers have done much in ironing out the ridges in rough roads by slowing up the action of the spring or reducing the intensity of the deflection or the rebound.

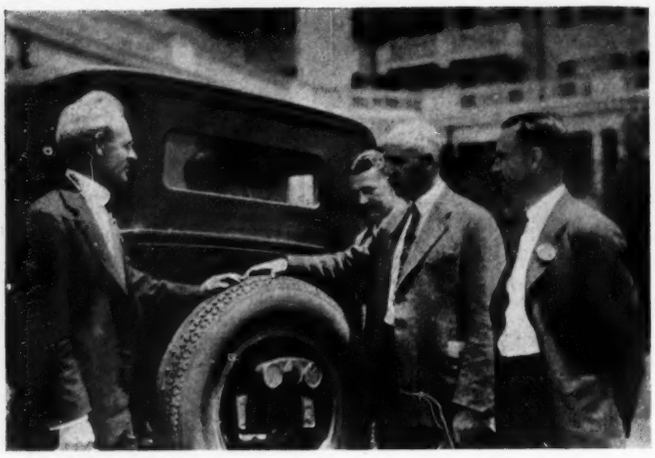
Horizontal or pitching motion can be almost wholly corrected by having the proper balance between the flexibility of the front and rear springs. For a car of 112 to 116-in. wheelbase, flexibilities approximating 140 vibrations in front and 75 vibrations in the rear, afford very good riding comfort.

A forward "caster" of the front axle and a corresponding tilting of the front springs serve as a means of absorbing the horizontal component of the average road shock. From experience, 2½ deg. has proved to be the angle at which road shocks are absorbed very well; it provides for easy steering, eliminates front-wheel wabble and allows the front wheels to straighten after rounding a corner.

Hugh A. Johnson, assistant engineer, Hupp Motor Car Co. C. E. Salisbury, service manager, Hupp Motor Car Co.



C. C. Carlton, secretary, Motor Wheel Corp. J. B. Siegfried, general sales manager, Motor Wheel Corp. Glenn A. Sanford, sales manager, Jaxon Steel Products Co.



Walter M. Newkirk, J. M. Kryder, J. E. Hale, Burton J. Lemon

The horizontal component of the road shocks should be as small as conditions will permit, as it reacts directly on the front spring bolt, causing considerable wear and puts a very unpleasant reaction on the frame.

Excessive pitching motion can be corrected in the design of the front spring. When the car strikes an obstruction in the road at a given speed the momentum sets up a couple at the base of the front tire and this must be resisted by the front spring. A low center of gravity will naturally decrease the magnitude of the couple and also reduce the resistance required of the front spring.

At high speed impact deflects the spring, storing up a certain amount of energy. The manner in which the spring dissipates the energy governs the intensity and amount of rebound transmitted to the frame. A flat spring, together with inter-leaf friction, will reduce rebound because of its damping qualities, giving a semi-shock-absorbing effect. To obtain the full benefit of inter-leaf friction, springs should not be lubricated between the leaves, unless used with some type of shock absorber.

Balloon tires and cushion springs play an important rôle in reducing vertical motion. Consider a specific road obstruction, taken at high speed; the low compressure or balloon tire absorbs a part of the road shock, the chassis springs and cushion springs absorb their share and the balance is transmitted to the passenger. If vertical motion is not reduced or modified in intensity, we have a very disagreeable rebound as a result.

At 50, and more, m.p.h. cars equipped with the larger section tires, the 6-in. and the 7-in. sizes seem to cause considerable side swaying. For this reason, although this occurs at high speeds, I believe cars should be equipped with tires of less than 6-in. section so long as we have the benefit of low pressure.

Very little change is necessary on front springs when used with four-wheel brakes. The springs should be flat under load and should be clipped properly to reduce the fanning of the leaves in the front when the brakes are applied.

Cars equipped with balloon tires require front and rear springs of increased stiffness. Fundamentally, we could shorten the front and the rear spring a trifle on account of the decreased deflection and consequent lower stresses, or we could use the same lengths of spring as at present but with heavier gages of steel. However, such a change is difficult to make because only a few makes of car have balloon tires as standard equipment.

Air Cleaner Problems Cause Disagreement

Difference of opinion arises both as to what constitutes an ideal cleaner and as to what kinds of material harm engines.

CONSIDERABLE difference of opinion which appeared during the air cleaner session of Friday morning served to demonstrate the interest in this subject of about 200 members who were in attendance. Some engineers maintained that the smaller particles of dust cause the greatest damage within the engine while others held opposite views. The importance of some protection against the entrance of dust into engines seemed to be generally appreciated, although opinions as to the requisite percentage of efficiency varied to a marked degree. Apparently, all of the engineers having experience in the tractor field insist on high efficiency while the passenger car and truck men are somewhat divided, with a decided leaning toward a somewhat lower degree of efficiency.

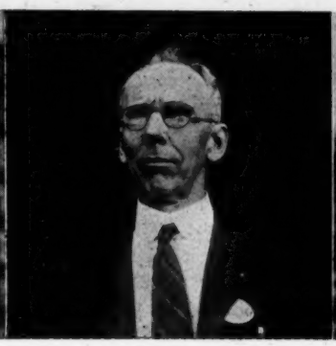
Many engineers are concerned about getting an air cleaner which sets up but very little vacuum ahead of the carbureter and which is small enough to go into the available space. Another troublesome problem is that of maintenance or care since motor car engineers feel that in order to be satisfactory, the air cleaner should require practically no attention from the owner. The car manufacturer's attitude was crystallized by a brief but pointed talk by P. S. Tice of the Stewart-Warner Corporation, who stated that the cost of additional equipment of any kind was one of the greatest drawbacks to the general adoption of the air cleaner at the present time. Furthermore, some manufacturers are somewhat concerned at the problem of getting a satisfactory cleaner into a relatively small space. Of equal importance is the question of care in the customer's hands, as it is pretty generally recognized that the owner will not devote much attention to the device. As the result of these things, many manufacturers are avoiding the issue. In Mr. Tice's opinion, the difference between the need of air cleaners on cars and trucks as compared to tractors is merely one of degree, and to be satisfactory the air cleaner for the passenger car should develop an efficiency of at least 98 per cent. He also feels that the larger dirt particles produce the greatest damage within the engine and therefore must be totally excluded as well as the medium size particles. The smaller particles, he thinks, are not very harmful. This latter opinion was not held by several other engineers, among whom was included H. M. Crane.

Tests Show Relative Efficiency of Air Cleaners

THE meeting was featured by the attendance of Prof. A. H. Hoffman of the University of California, who recounted the progress of his air cleaner tests in a paper on "Air Cleaner Investigations." He emphasized the fallacy of using fullers earth for air cleaner tests and stated that he had found a standard dust more satisfactory in

E. B. Sturges described the Weiss transmission which was commented upon by many engineers

L. L. Dollinger read a paper at the air cleaner session



A. H. Hoffman, University of California, gave the results of extensive air cleaner tests

H. T. Owens, National Gage & Equipment Co.

producing consistent results. He also advised against road tests as the sole standard of air cleaner efficiency and described the apparatus which he had developed over a period of about four years. This apparatus, as well as the results of many of his tests, already have been published in AUTOMOTIVE INDUSTRIES. As an index of the value of the air cleaner he cited the case of two cars which have been driven about 27,000 miles on the Pacific Coast. The engine which was fitted with an air cleaner showed but .001 in. wear at the cylinder barrels and required no overhauling at the end of this mileage. The engine which had no air cleaner attached showed .008 in. wear at the same point and required a new set of pistons and rings as well as some valves. These cars had been driven under comparable conditions. Mr. Hoffman said in part:

The laboratory tests here reported follow closely those of the 1922 series. The road tests were run because to some cleaners sent in for test the regular laboratory test was inapplicable. Two main things are sought: first, to find out how much dust the engine would draw in if cleaner and stove and their connections were removed; second, to catch and weigh what the tested cleaner fails to catch. To determine the dust encountered a 2 in. O. D. 90° L of plumbers thin brass tubing is placed with its opening forward on the level of the midline of the radiator core and longitudinally and latterly as near as possible to the regular position of the carbureter inlet of the car or truck on which the test is made. The hood is closed, holes being cut for connections to absolute cleaner. The absolute cleaner is a slight modification of No. 17 of the 1922 test series. The run with cleaner off is made as nearly as possible like that with cleaner on.

Dust is raised by a leading car 50 ft. ahead. For heavy dust conditions a standard chain is dragged in a loop. For medium dust, no drag is used. The dust per mile caught in the absolute is made the basis of efficiency determination.

What Dust Does to the Interior of Engines

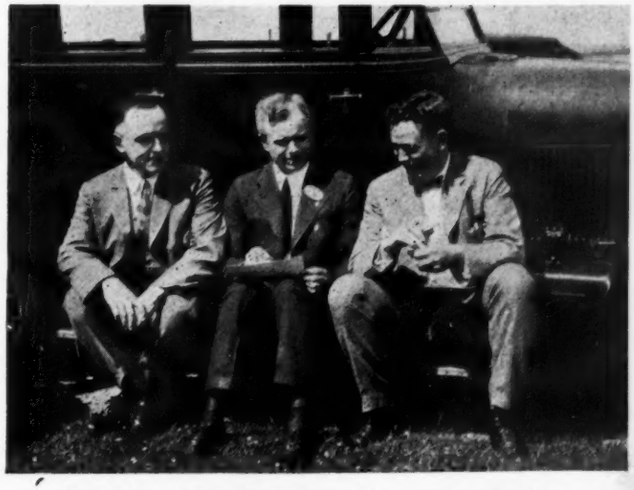
AIR filters were discussed by L. L. Dollinger, who reviewed the effects of the entrance of dust and dirt into the interior of engine. He stated that approximately $100,000,000 is spent annually for replacement pistons and rings and that about twice this amount is required for the labor of installation. He also averred that worn bearings, resulting largely from the entrance of dirt, are responsible for the waste of 750,000,000 gal. of fuel per year. The substance of Mr. Dollinger's paper is digested as follows:

The difference between a new quiet and efficient engine and an old noisy and inefficient engine is simply a matter of wear.

Most manufacturers of motor vehicles have recognized for some time that road dust, sand and grit, drawn in through the air-intake of the carbureter, cause wear, but many think that occasionally changing the oil that has become gritty in the crankcase is all that is necessary to protect the engine. It is desirable to change the oil frequently, but before the dust and grit reach the crankcase the greater part of the damage to the engine has been done.

In the first place, there is more dust and grit in the air than is generally believed. Not only the wind, but the wheels of other vehicles, and especially street cars, moving at high speed, set in motion enormous quantities of road dust. Road dust consists mainly of ground-up pavement, with sand and grit blown from the roofs of buildings. An appreciable amount of coal dust, sand, gravel and cement is scattered over the city by trucks carrying these abrasive materials. Since the intake velocity of air in a carbureter is generally from 50 to 150 ft. per sec. the suction is so great that particles of sand and grit near the air-intake opening are drawn into the engine.

Consider the piston of an engine as it moves down on the intake stroke, leaving the cylinder wall coated with a film of oil. The air, charged with dust and grit, enters the cylinder at high velocity and strikes the oil-film on the cylinder wall to which the finer particles of grit readily



Franklin Manufacturing Co. representatives. E. S. Marks, Assistant Chief Engineer. L. M. Stellmann, Chief Engineer. G. R. Murphy, Assistant Vice-President

adhere. As the piston moves up and down, the gritty oil rapidly wears the cylinder walls and the piston-rings. The grit works into the ring grooves and wears both the grooves and the sides of the rings.

It is estimated that 15 per cent of the more than 5,000,000,000 gal. of gasoline consumed annually is wasted by reason of worn cylinders, pistons, and piston-rings. Leaky valves and excessive carbon deposits are also contributing factors.

Carbon is generally said to be the cause of leaky valves. More careful study of the matter develops that it is not carbon but rather particles of sand and grit, coated with carbon, that hold the valves open.

A good example of the actual cost of overhauling an engine and the relative cost of overhauling the complete vehicle are given in a recent article by E. E. LaSchum of the American Railway Express Co. That company operates over 2500 gasoline vehicles, and it may be assumed that the costs are similar to those of other large operators who maintain efficient repair shops and who have some advantage in buying parts in large quantities.

An examination of the data submitted shows that the cost of overhauling an engine, exclusive of the carbureter and the magneto, is more than $550. This represents nearly 40 per cent of the cost of overhauling the entire vehicle.

Laboratory Test Results

A well known engineer responsible for the operation and maintenance of one of the largest fleets in the United States and having extensive laboratory facilities at his disposal, made careful measurements of the cylinders, pistons and ring groove clearances of two brand new high grade four-cylinder truck engines of the same make and model. These engines were connected to block-test dynamometers. A dust box was provided about 8 ft. high, 4 ft. wide and 3 ft. in the other dimension. In the bottom of the box was placed a quantity of actual road dust, which was kept agitated by a fan so that the lighter particles that would float readily in the air would rise to the top of the box. Dust-proof flexible tubing was used to connect the carbureter air intakes with the inside of the dust box. Both these tubes terminated near the top of the box. Inside the box an efficient air filter was connected to one of the tubes so that all the air entering the engine was protected against dust and grit. The opening in the other tube was left unprotected. The engines were run about 240 hr. at the normal governed speed and load, after which they were taken down and measurements again were taken of the cylinders, pistons and ring groove clearances. The average wear was as follows:

Measurements of Wear in Engines

Name of Parts	With Filter	Without Filter	Relative Wear
Cylinder walls	0.0011	0.0090	1:8
Pistons	0.0005	0.0036	1:7
Upper ring-groove clearance..	0.0110	0.0650	1:6
Middle ring-groove clearance.	0.0040	0.0660	1:16
Lower ring-groove clearance.	0.0014	0.0230	1:16
Percentage of incombustible matter in carbon.....	6.5	31.0	1:5

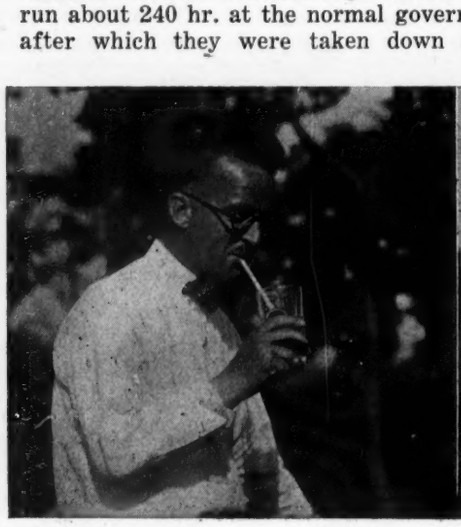
It was further observed that the oil consumption was 40 per cent greater during the last 80 hr. of the test.

Since it has been found desirable to keep road dust and grit out of an engine, the most important characteristic of a filter is high efficiency. Some engineers and superintendents in charge of operating fleets have given as their opinion that it is necessary to remove only the large particles of grit from the air supply. Though there is some advantage in keeping out the coarser particles, it has been found that the finer particles are the more destructive. In certain sections of the Pacific Coast territory, where the most trouble with engines is experienced, the dust is extremely fine and floats in the air at very low wind velocities.

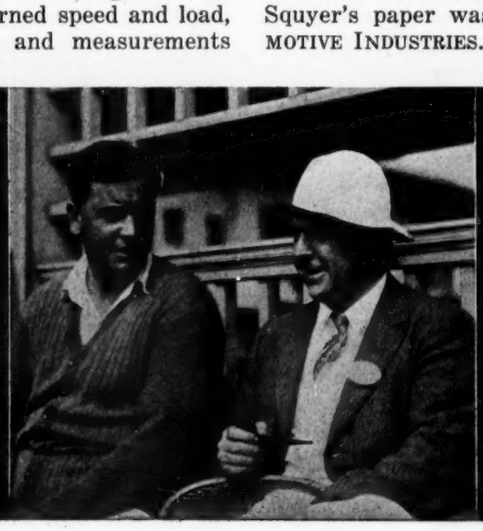
The filter or other device for excluding dust and grit from the air, in order to be effective, must remove a very high percentage of any kind of dust or grit and must function efficiently at any engine speed.

Other desirable requirements in a satisfactory filter are low resistance or restriction to the flow of air, durability, and the minimum amount of attention. It is also desirable that it be reasonably small in size and light in weight and have as few moving parts as possible. For use on passenger cars it is important that it be neat in appearance. Some filters produce a very good muffling effect on the noise caused by the inrush of air into the carbureter.

Considerable favorable comment was aroused by the paper "Testing of Air Cleaners," which was presented by A. R. Squyer of the Holt Caterpillar Co., as the author not only covered thoroughly a method of testing but also discussed methods and apparatus which had not proved satisfactory. Many of the members stated that a paper dealing with a few of the failures had more value than one which covered merely an outstanding success. Mr. Squyer's paper was digested in the last issue of AUTOMOTIVE INDUSTRIES.



E. E. Wooler, chief engineer, Cleveland Automobile Co., enjoys himself after a hard golf match



E. C. Gutterson, Rubber Shock Insulator Co., and Lowell H. Brown, Belflex Corp., talk over a game beside the tennis courts

Percival S. Tice, engineer, carbureter division, Stewart-Warner Speedometer Corp., looks over the Daily SAE before giving his talk at the air cleaner session

Centrifugal Air Cleaner Advantages Outlined

The session was concluded by a paper by C. P. Grimes of the United Manufacturing and Distributing Co., who dealt with the self-ejecting centrifugal type of cleaner in his paper, "Recent Observations of Air Cleaning Devices," which is digested as follows:

The entire automotive engineering fraternity now look to clean air for increased engine-life. We do not change the lubricant in our transmissions and differentials each 500 or 5000 miles because they are sealed dust-tight.

Before getting excited over the problem of crankcase-oil dilution, we should stop to consider the performance of the old reliable two-cycle marine engine that would run for days and days under full load on lubricating oil fed to it in the fuel. This was absolutely satisfactory because the oil was clean, and gave excellent engine-life, fully twice that now obtained by an unprotected automotive engine.

The self-ejecting centrifugal type of cleaner contains but one moving part, made from aluminum stampings mounted to rotate upon a single steel ball-bearing. This bearing is cushioned against mechanical shock by adequate felt pads that act as oil reservoirs, with a retaining capacity of 65 drops of oil, which is ample for 2 years of continuous service.

To separate even 99 per cent of all dust particles from each particle of air would require an unreasonable expenditure of power at enormous speed. The designer of the self-adjusting centrifugal cleaner discovered that almost no power at all is required to centrifuge all of the dust particles into the outer-zone which comprises one-quarter of the air volume in the cleaner.

The entire rotating member also acts as a "flywheel" to the carbureter air-stream. It may pull or push as the occasion demands, to smooth-out those violent surges that are so common at low-speed full-power, to the extent of actually increasing the engine torque as much as 8 per cent, with less fuel as noted in Table 2.

TABLE 2—EFFECT OF THE CENTRIFUGAL-EJECTOR AIR-CLEANER ON TORQUE, FUEL CONSUMPTION AND YOKE SUCTION

	Without Cleaner			With Cleaner			Advantages	
Speed, R.P.M.	Load, Lb.	Fuel Consumption, Pt. per Hr.	Yoke Suction, In. of Mercury	Load, Lb.	Fuel Consumption, Pt. per Hr.	Yoke Suction, In. of Mercury	Torque Increase, Per Cent	Fuel Consumption Decrease, Per Cent
200	89.5	8.5	0.10	96.7	7.4	0.10	8.00	12.95
400	102.0	15.5	0.20	107.0	13.9	0.15	4.90	10.31
600	105.5	20.8	0.35	107.2	19.7	0.35	1.60	5.10
800	102.5	25.8	0.45	103.5	23.2	0.55	0.97	10.08
1,200	107.8	36.3	0.85	112.8	34.5	1.00	4.64	4.97
1,600	107.4	46.0	1.35	107.5	45.0	1.50	0.93	2.08
2,000	100.5	54.0	1.80	100.0	51.0	2.10	0.50[a]	5.55

The data shown in Table 2 were obtained from the laboratory of a prominent six-cylinder-engine automobile manufacturer. The first run was made under the conditions of its standard production adjustment. The second run was made with the centrifugal air-cleaner attached after one or two trials of gasoline adjustment had been made to compensate for the slight amount of air resistance added by the cleaner.

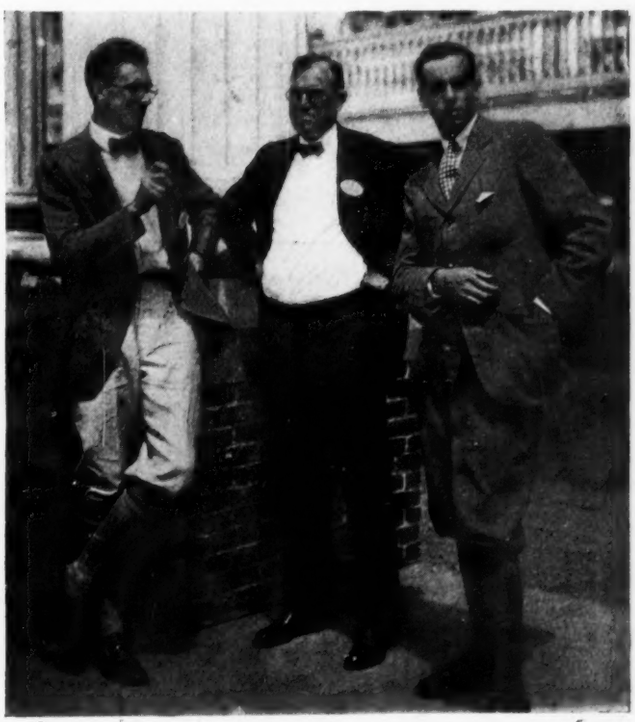
Minor Changes Made in Standards Report

Discussion results in modification of proposals on parts and fittings and on agricultural equipment submitted by committee.

DETAILED changes rather than outstanding issues were the chief considerations of the meeting of the Standards Committee during Thursday morning. Most of these changes were made to conform with improved commercial practice or to coincide with the standards developed by cooperation with other engineering societies and associations. While the report of the lighting division probably constituted the most important part of the meeting, practically no changes were made, and this report with the addition of standards for gas headlamps was passed without negative discussion. This report was included in the article covering the reports of the various committees which appeared in AUTOMOTIVE INDUSTRIES of June 19.

As presented by C. A. Michel and passed by the Standards Committee, gas headlamps are to be equipped with ⅝ cu. ft. burners, mirrors measuring 6 in. in the contour of the reflecting mirrors and 5⅛-5⅝ in. on the diameter. The focal length is 2⅛-2½ in.; the front glass is to be clear and the mean spherical candlepower of the lamp is to be 21. Lamps must be of substantial construction and carry an identification tag which will specifically state the gas consumption in cu. ft. per hr.

Considerable discussion was evoked by the report of the Parts and Fittings Division, comment being centered on the matter of policy regarding the adoption of a patented article as a standard. This discussion was brought about by the inclusion of compression type tube fittings in the report. However, after considerable comment which was led by Messrs. Crane, Bachman, Scaife and others, this section of the report was approved and referred to the council.



A. Ludlow Clayden, Sun Oil Co., read a paper entitled "Water in Crankcase Oils." He is talking to Harold L. Pope, Wright Aeronautical Co., and to Arthur Pew of the Sun Oil Co.

The report of the agricultural power equipment division also stirred up considerable comment, which was directed at the inclusion of the paragraph headed Adulterations in the list of belt specifications. It was thought that stipulations of this sort are somewhat out of the field of the society, and if included should be accredited to the society or body involved in the particular field. A motion confirming this opinion was passed, although that portion of the report referring to belt specifications was voted out and referred back to the division. The balance of the report referring to tractor specifications, power take-off speed and canvas and rubber driving belts was passed.

T. V. Buckwalter of the Timken Roller Bearing Co. presented the report of the Ball and Roller Bearing Division, which was approved. This report covered the increase of the width of ball bearings Nos. 200-205 to conform with present practice and improved design. In the absence of W. R. Webster, the report of the Non-ferrous Metals Division was read by R. S. Burnett and passed by the Standards Committee. Only detailed changes to conform with present practice were involved.

The report of the Springs Division was accepted with the elimination of the paragraphs on motor truck springs and leaf spring stock. A few detailed corrections were made in the proposed standards for leaf spring definition, chiefly for the sake of clarity. Also, the restriction covering readings and loading removed from the paragraph on testing.

Although a report of the Aeronautic Division was published, Henry M. Crane, chairman of this division, stated that in spite of the hopes of bringing this division out of its obscurity, it had been decided to withdraw the report. The report of the Screw Threads Division was accepted, although some comment was aroused by the proposed standards for high nuts. It was explained that some of the detailed dimensions anticipate a further report on standard nuts. Although some criticism was directed at the counterbore at the bottom of the thread, the report was adopted so that the basic dimensions would be available to manufacturers and serve to clear up the indefinite situation which exists at present.

During the course of the meeting Clarence Carson of Dodge Bros. mentioned briefly a machine that has been developed for testing brake linings, advising that prints of the device and performance curves are available to those interested. Mr. Carson also stated that tests made on the machine are not directly comparable to field service, although a lining which shows superiority in the machine test will probably last somewhat longer in actual service. However, the findings of the machine test should be confirmed by extensive tests on several cars.

Sliding Gear Transmission May Be Replaced

Engineers believe adoption of infinitely variable models may come within a few years. Recently developed types are shown.

THE infinitely variable transmission and some of the intermediary stages leading to its development formed the subjects of session of Thursday evening which was attended by about 175 members. Jos. A. Anglada presided. Judging from the papers presented and the comment which they aroused, engineers feel that the time is not far distant when the present sliding gear may be replaced by other devices. Although the adoption of infinitely variable devices can not be expected immediately, their use is likely before many years have elapsed. While the cost of such devices may exceed that of the sliding gear type, it may be assumed that the advance of manufacturing methods will keep pace to bring them within the range of relatively economical manufacture.

As introduction to the subject, Prof. J. M. Nickelsen reviewed several developments in the direction of the infinitely variable transmission and established some of the fundamental requirements as well as their ultimate influence on the design of the entire car. His paper, Automobile Transmission Tendencies, is abstracted as follows:

S. A. E. Sections Committee

Mason P. Rumney, vice-president, Detroit Steel Products Co.

Frederick G. Hughes, vice-president, New Departure Manufacturing Co.

Hiram L. Walker, chief engineer, Chandler Motor Car Co.

Col. M. G. Baker, Vanadium Corp. of America

Ideal Transmission Requirements Outlined

THE requirements of a good transmission are that it shall:

Increase the torque of the engine
Operate at an efficient rate
Be easy to control or operate automatically
Be comparatively simple in design
Stand up in service

Under very favorable conditions the power loss through the gear transmission is small, but when taken under more adverse conditions the loss may be extremely great. For general summer driving, we might expect an average efficiency through the transmission of from 90 to 95 per cent. In winter driving, it is doubtful whether the average person would get better than 80 to 85 per cent efficiency.

Even with the conventional gear transmission, it seems that we should be capable of overcoming some of these losses by a lubricant with a narrower range of viscosity.

Noiseless operation with the opportunity of shifting into any gear in the hands of the most inexperienced driver is claimed for the Campbell transmission. This permits of using the engine as a greater braking force in traffic by shifting down to first or second gear.

There have been a great many devices brought out to eliminate the conventional control lever of the transmission. Most mechanisms of this type function by means of the selection being made through some device on the steering column and the gears shifted by means of the clutch pedal. A similar type of control mechanism makes the gear selection by means of push buttons, which are on a small box attached to the steering column.

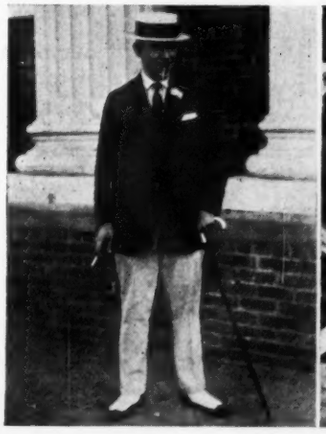
Some passenger buses in Germany have recently been equipped with a gear transmission which is hydraulically controlled. All gears in the transmission are constantly in mesh. At all times it is necessary to drive through one set of gears. The gears are in two parts but held together, and within each is a two part hydraulically operated clutch of the multiple cone type. The clutch parts are held to the main shaft by feather keys, which permits them to slide freely along it.

The essential units of the electric transmission are the generator, control system and driving motor. Some electric transmissions employ a magnetic clutch for driving directly through in high gear, which seems very desirable, as the efficiency then is very good compared to about 80 per cent when working through the generator and motor.

At first thought, the electric transmission seems to make the automobile chassis more complex, but we must remember that when it is used we can dispense with the flywheel, clutch, gear transmission, present small generator and starting motor and one set of brakes.

It may be of interest to know that several hundred buses in England are in operation with electric transmissions and that they are being tried out in this country for that class of service.

The hydraulic transmission has made its appearance in hundreds of forms, the claims for which have been unlimited. A great many of these mechanisms are nothing more than a hydraulic brake, in which it is impossible to increase the torque, and the action is that of a slipping clutch.



T. G. ("Goldie") Meachem, Meachem Gear Corporation

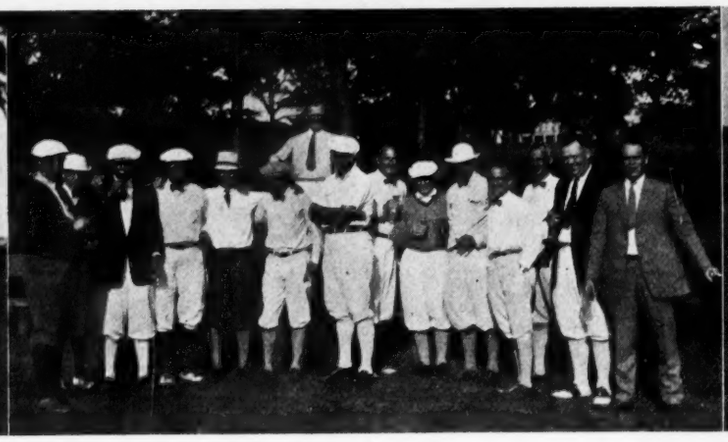
C. H. Foster, president, Gabriel Manufacturing Co.

The de Lavaud transmission system has been experimented with for several years and very successful operation is claimed for it. At the present time one light weight car has adopted it for production.

The public will ever demand riding comfort in the selection of an automobile. Other things being equal, the weight of the car is an important factor.

The rapid improvement of our highways is making it possible to give better riding comfort for less car weight.

M. Howard Cox was runner-up to F. W. Davis in the championship flight



Some star golfers at the nineteenth hole

Webb Jay topped the second flight in the golf tournament

The recent debut of the balloon tire also bears greatly on the riding comfort of the light car.

Infinitely Variable Transmission Described

IN a paper entitled, A Positive Mechanical Continuous Torque Variable Speed Transmission, E. B. Sturges of the Weiss Engineering Corporation described the Weiss device, which was discussed in a recent issue of AUTOMOTIVE INDUSTRIES. This device consists of a rotor which is driven by the flywheel or as alternative a hollow spherical element which may be attached directly to the flywheel, also forming a portion of the rotating weight. By means of ball bearings which form rollers that are wedged into contact with the hollow sphere and either a universal joint or universal gearing, the speed and therefore the torque at the driven shaft may be varied at will by the operator by means of a control lever or a torque governor. The device can be arranged to transmit no rotation, to act as a brake on the rear end and to give direct drive forward or a comparatively low reduction

O. E. Hunt, General Motors Research Corporation

in the reverse direction. Among its outstanding advantages are stressed infinite torque and speed changes without the necessity of clutch operation, the ability to act as a brake and better economy, since the engine can work at all times under the highest allowable pressures. Mr. Sturges predicted that, with this device, smaller rear axle ratios could be used and compared the characteristics of the car when so equipped with the steam-driven vehicle. His remarks were borne out by T. J. Litle of the Lincoln Division of the Ford Motor Co., who stated that this device had proved a revelation to him.

Another device of the infinitely variable type was discussed by W. A. John, although the features of construction follow an entirely different trend. Mr. John's device includes a high speed friction clutch, which is operated by centrifugal weights and cuts in at any predetermined speed between 10 and 15 m.p.h., depending upon the size of the car and engine. This is splined on a shaft, which extends clear through the transmission and terminates in the propeller shaft universal joint at the rear. Just back of the high speed clutch is another similar clutch which is also operated by centrifugal weights which cut into operation as soon as the control lever is moved to forward or reverse from the neutral position. The second or low-speed clutch operates a four-stage hydraulic motor, all of the stages being in operation when the torque is high as when starting from the curb or ascending a hill. As the speed increases or the torque requirement decreases, these stages are cut out one by one by means of a four-stage cylindrical valve until direct drive is reached. At this point an over-running clutch at the back of the hydraulic unit goes into effect and the hydraulic unit remains stationary. The hydraulic motor consists of four pumps of con-

O. F. Ostby, General Sales Manager, Prest-O-Lite Co., and A. K. Brumbaugh, Autocar Co., enjoyed the swimming

Harold W. Slauson and R. M. Owen, Owen Dyneto Co., try out some golf strokes on the porch

ventional design, equipped with non-metallic vanes. Each of the pumps is timed so that no undue compression or an air lock can result.

In the fourth paper of the evening W. A. McCarrell described a constant mesh transmission, which is his development. A spiral gear device of this kind already has been described in AUTOMOTIVE INDUSTRIES and this was supplemented in the paper by a more recent spur gear development. In this transmission, instead of shifting the gears in the usual manner shifter collars are shifted over roller clutches, which are integrally formed in the ends of each of the gears. The paper placed great stress on the ease of shifting, quietness and the relative manufacturing problems. Mr. McCarroll said:

New Constant Mesh Transmission Developed

GEAR shifting as related to the various types of sliding gear transmissions has been one of the big drawbacks, leaving something to be desired in the hands of all but the most expert drivers. Those who can shift from low up to high with any degree of uniformity and quietness are in the minority, and in spite of the known advantages of the engine as a brake in hilly country, but very few people have any luck in shifting to the next lower reduction while the car is moving at any appreciable speed.

J. G. Vincent, vice-president in charge of engineering, Packard Motor Car Co.

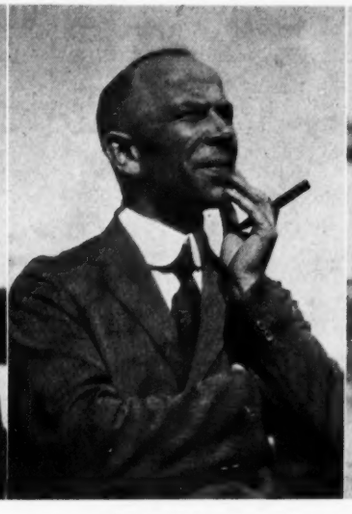
In getting away from the clash gear the first step was the friction type of transmission which has practically disappeared due to its obvious disadvantages. The next step is the constant mesh transmission in which the gears are engaged at all times and the reduction is varied by picking up and locking the desired gear to the shaft.

The McCarroll Constantmesh Transmission bears a considerable resemblance to the conventional three-speed and reverse type in that the gears are arranged in the same order from front to rear and reductions are obtained through a step down gear at the front end, which in turn drive a lower shaft fitted with fixed gears that engage with corresponding gears on the tail shaft. Although shifting is accomplished by the usual hand lever mounted in a spherical bearing, or mechanical shift, slip collars rather than the gears on the upper shaft are moved to engage the various reduction sets.

With regard to this type of roller clutch which is one of the distinctive features of this transmission. Clutches of this type have been used extensively in marine work for reversing gears in which no friction clutch is included. Shifting under these conditions is accomplished

F. F. Chandler, chief engineer, Ross Gear & Tool Co.

Frederick S. Duesenberg, chief engineer, Duesenberg Automobile and Motors Co.

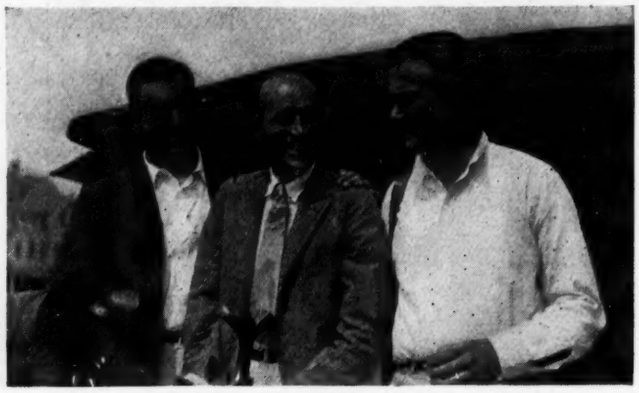


Otto M. Burkhardt, consulting engineer, Pierce-Arrow Motor Car Co.

A. W. S. Harrington, Quartermasters Corps, brought a new four-wheel drive truck to the meeting

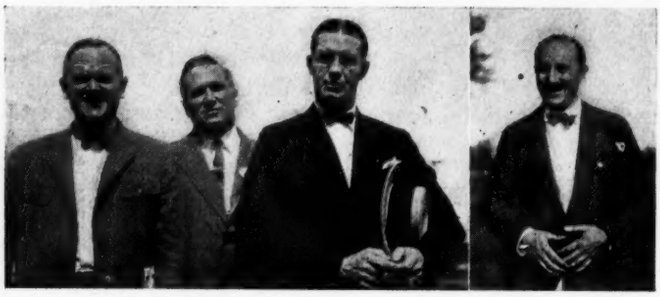
R. A. Long, Chief Engineer, Columbia Motors Co.

C. P. Grimes outlined principles underlying the design of the United Air Cleaner



Thermoid Rubber Co. representatives. C. A. Schell, A. H. Greywary, F. H. Sharpe

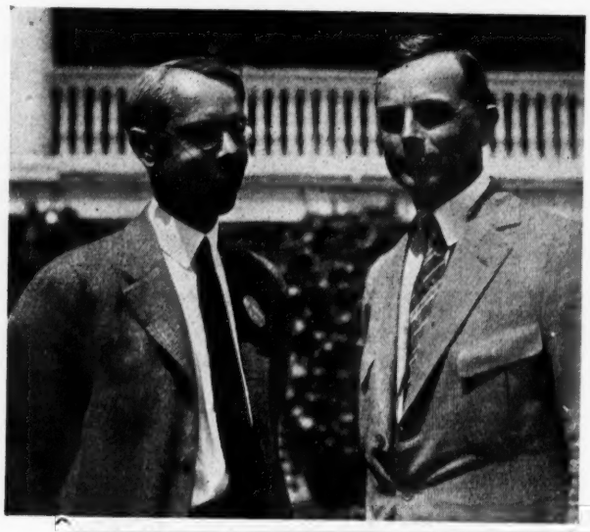
Francis W. Davis won the golf championship



The daily SAE was published by the Prest-O-Lite Co. Here is part of the staff: Alexander Johnson, O. F. Ostby, editor; Frank L. Parrell, Nathan Lazarnick

R. F. Ellis had the high score in trap shooting

F. D. Heath, Jones & Laughlin Steel Corp.; R. F. Ellis, Foss-Hughes Co.; W. H. Miller, International Metal Hose Co.; Orrel A. Parker, Parker Wheel Co.; R. M. Owen, Hudson Motor Car Co.



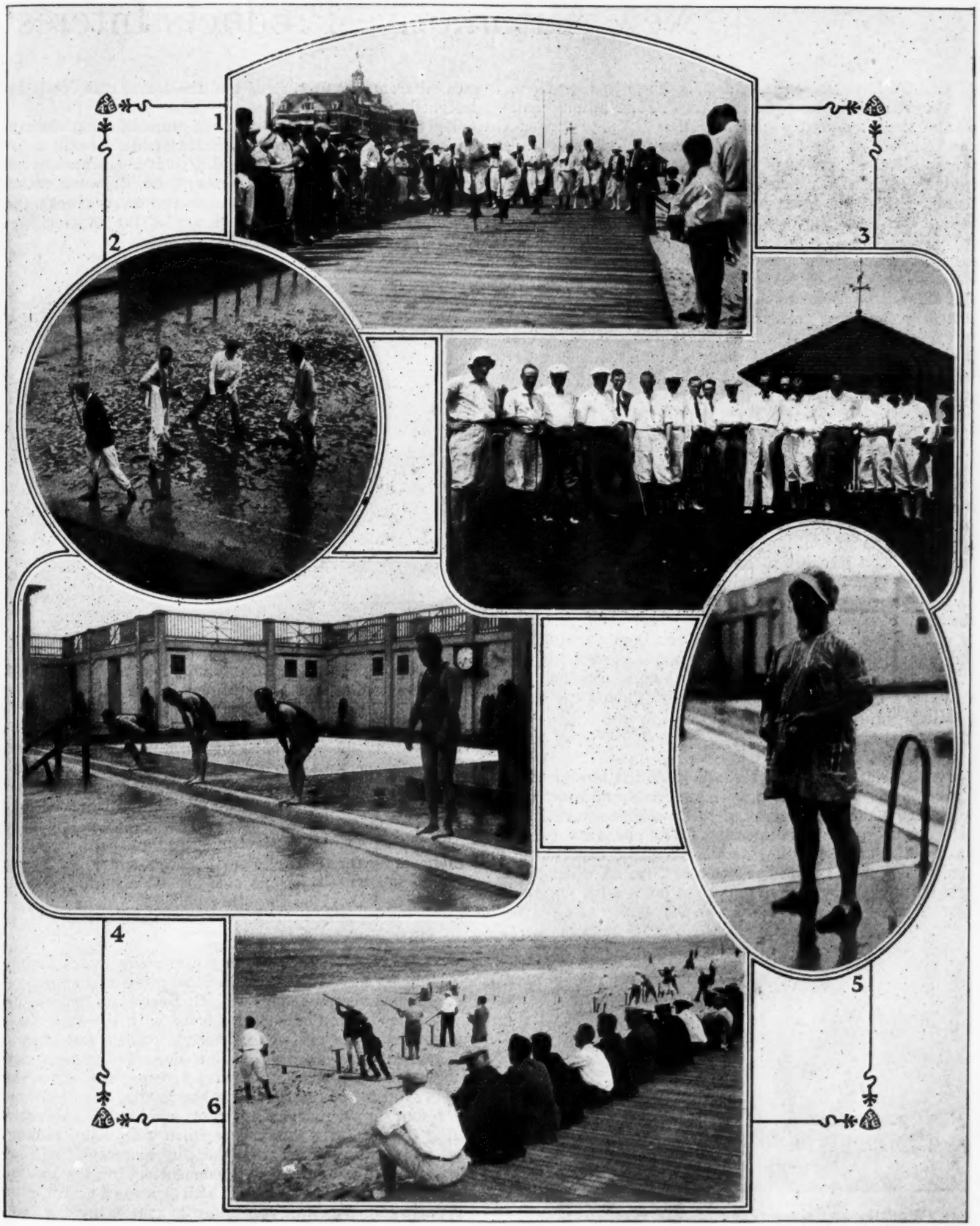
H. E. Maynard, engineer in charge of design, Maxwell Motor Corp.; Carl Breer, Chrysler Motor Co.

with entire satisfaction and the direction of the propeller with its inertia load, can be reversed instantaneously. A test car has been driven for more than 1000 miles, but one roller in each gear. This test was extremely severe as the allowable backlash between the shaft and respective gears set up undue conditions of impact. The same construction which was devised six years ago is now being adopted for the change gear boxes of machine tools with no related friction clutches.

Economy of manufacture is one of the salient features of this transmission. No unusual parts requiring elaborate equipment are involved. Milling of the jaws at the ends of the gear hubs is probably the most complicated operation in the whole assembly and this operation can be performed with great accuracy and speed in an ordinary horizontal milling machine.

To supplement the papers with their stereopticon illustrations each of the speakers had working models.

S. A. E. Sports Reviewed by the Camera



Photographs by N. Lazarnick

1—Finishing was the hardest thing to do in the pogo stick race. 2—Final of the tennis doubles was played in a pouring rain. 3—A group of golfers just before play started in the championship round. 4—The start of one of the swimming races. 5—"Big Brummy" showed the crowd a good time at the water sports. 6—The trap shooters performed on the beach

New Automotive Products Interest

FOLLOWING his showing of a six-wheel Quartermaster Corps truck of last year, A. W. S. Herrington, chairman of the Washington section of the S. A. E., showed a new four-wheel drive 1½-2-ton truck this year. While this job is assembled from commercial units so far as the engine and gear box are concerned, it has several unique features. The step-down gear which transmits the drive to both propeller shafts is mounted amidships. A 14 in. winch, which is driven through a 125:1 reduction, is located at the rear end and is unusual in that the winch is located below the center of gravity of the whole truck, and allows free access to the loading platform. This eliminates the tendency to rare up which is characteristic of many winch installations. Herrington did not drive over in the truck but came in his coupe which is built on a Yellow Taxicab chassis which has balloon tires and all the other modern fixings.

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THE large number of cruising demonstration cars must have increased materially the wear and tear on the nerves of the regular Spring Lake inhabitants. Four-wheel brakes, balloon tires, transmissions, fuel economy devices and many other products were fitted on special cars. A large proportion of the demonstrations seemed to involve twisting the steering wheel from side to side so that the car going down the street looked like some of the conventionites coming down the hall after midnight or getting the car up to 50 m.p.h. and then slamming on the brakes to permit turning a 45 degree corner. It is a tribute to the efficiency of the various units demonstrated that there wasn't a sign of an accident during the whole meeting.

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MACK'S latest design of shock insulated bus provided transportation for many members from New York to Spring Lake and several of these vehicles were available for use during the meeting. The chassis employed has been altered in a few details since the experimental model was shown last fall at Atlantic City. A wider front axle is fitted to make the front tires track with the outer rear tires, the wheelbase for the city type has been increased from 192 to 196 in., and the frame completely redesigned.

The frame is not kicked up, but is tapered from the center, where it is 8 in. high, toward both ends. It still is flat on top, but the design is such that reinforcements are not required. Tubular torque members, the forward fitting for which are combined with the shock insulator housings, are employed. Shock insulators are of the floating type and radiator shutters have been added.

Mack buses were on hand to take guests to the tennis courts and golf course

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The new four-wheel drive truck, latest development of the engineering department of the U. S. Quartermasters' Corps.

GEORGE L. SMITH of the United States Ordnance Co. drove to the meeting a Hupmobile fitted with front and rear brakes. Both pairs of brakes are fitted with Smith's automatic equalizing device which insures the same braking on each band of each pair. This device, described some time ago in these columns, has been simplified materially by elimination of the backing latches which proved unnecessary. The installation referred to is the first applied to front wheel brakes. Stops can be made with both hands off the steering wheel and with no apparent tendency for the car to deviate from a straight course even though wheels on one side are on a quite different footing from those on the other side.

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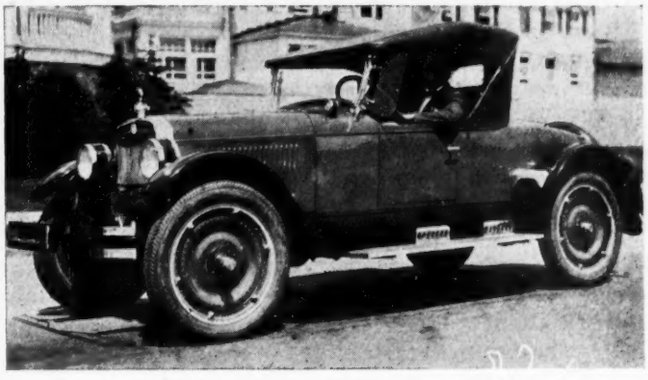
S. W. RUSHMORE drove to the meeting in his Crane-Simplex fitted with the Rushmore steam cooling system and was accompanied by A. G. Herreshoff, who drove a recent model of Cadillac also fitted with the same cooling system. This system of cooling, which embodies a number of improvements since last described in these columns, is attracting much attention, especially since the papers read at the meeting have shown that it is desirable for a number of reasons to run engines at somewhat higher temperatures than are common with water cooling. Maximum temperatures with the Rushmore system, however, are no greater than with conventional water cooling. Mr. Herreshoff is leaving the Fifth Avenue Coach Co. on July 1 to join with Mr. Rushmore in marketing the cooling system.

Engineers at S. A. E. Summer Meeting

WILLIAM H. HILL showed an old Moline-Knight car fitted with a vaporizing device which is said to remove liquid fuel from the charge entering the cylinders, especially during the starting period. With this device in use it is claimed that it has not been necessary to drain crankcase oil from the engine for a period of two years during which the car has been driven many thousands of miles.

FOR people who appreciate something different, Ray A. Long, chief engineer of the Columbia Motors Co., brought a brand new Columbia Tiger to the meeting. This sport roadster is finished in two-tone brown with the darker shade above the forward portion of the belt. The



The Columbia Tiger, a new sport roadster, was shown for the first time by the Columbia Motors Co.

equipment is complete including all of the usual accesories, windshield wings, nickel-plated bumpers and bumperettes, pistol grip spot light and a seat for the guests which folds into the rear deck. Disc wheels and Lockhead four-wheel hydraulic brakes are additional features.

THE big Navy dirigible, Shenandoah, furnished diversion for the engineers and their guests by flying over Spring Lake just about dinner time on Tuesday evening. Just as it was sighted and as the crowd was rushing from the hotel lobby to catch a glimpse of the big blimp, A. K. Brumbaugh set off the first bunch of giant firecrackers which he had brought along to entertain himself with. Someone set up the cry, "The Shenandoah has burst," and then the crowd came faster. But it was quickly discovered that the noise had only arisen from "Brummy" at play.

NOBODY could complain that they didn't know when the sessions were about to begin this year. Assistant Manager Hill of the S. A. E. hired a pair of Boy Scouts, dressed them up as sandwich men and gave them each a good sized bell. Then he sent them through the lob-

Two boy scouts with large bells called the members to the meetings

bies and porches of all three hotels during the ten minutes preceding the opening of each session. Everybody heard them and an unusually large proportion of those at the convention followed them to the meeting hall as the children are said to have followed the pied piper. It pays to advertise.

A NEW Paige brougham equipped with Van metal wheels was very much in evidence around the Monmouth. This wheel which is the product of the Van Metal Wheel Co. of Oneida, N. Y., is made up in four hollow-spoke metal sections which are tongue and groove jointed together. Light weight, smooth, easily washable contours and absence of squeaks due to moisture and other climatic conditions are some of the advantages which are claimed for this type of wheel. As the spoke and rim construction is aluminum, the wheel has considerable value in radiating the heat of the tire.

Van Wheel Corp. showed a newly designed aluminum spoked wheel

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The AUTOMOBILE
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Car Owner Viewpoint in Engineering

THE car owner, the real boss of the automotive industry, is getting more recognition every day. The sales managers have been trying hard to please him for many years, but the engineers and production men haven't been on such familiar terms with him as they might have been. Technical workers often have had a habit of looking to the laboratory for suggestions on how to improve their designs and a tendency to keep their backs turned to the public.

But all that has changed. The engineers not only are accepting criticism from owners as a guide in designing, but actually are going out to get the opinions and experiences of users. This was evident from the point of view taken by almost every speaker at the summer meeting of the Society of Automotive Engineers last week. While the car user wasn't mentioned by name very often, his viewpoint was expressed many times.

A whole session, for example, was devoted to the subject of riding comfort and one of the chief ideas developed was the necessity for finding out with some degree of accuracy just what "riding comfort" means to the average car owner. Instruments to determine the effect of present design on the rider were discussed and suggestions for future experimentation were made. The question of crankcase oil dilution, although argued in a highly technical manner, was approached largely from the same point of view. In the back of everyone's mind seemed to be the question, "How can the problem be solved so as to get maximum performance with minimum inconvenience to the user?" New transmission designs aroused a very real interest because it was thought that they might point the way to easier car operation.

With this new appreciation of owner viewpoint has come a better understanding of the real possibilities of research. Having found out the general kicks of the average car owner, the engineers are going into the laboratories to devise means of reducing those general objections to specific terms so that they can be overcome in a practical and thorough manner.

Castor Oil Insoluble with Gasoline

IT has sometimes been stated that castor oil and gasoline are mutually insoluble, and therefore that in the operation of an engine lubricated with castor oil, dilution by fuel is avoided. To test the truth of this statement, mixtures of gasoline and castor oil were made up containing 5, 10, 20, 30, 40, 50, 60, 70, 80, 90 and 95 per cent gasoline.

This was done for each of two commercial grades of gasoline and five grades of castor oil. One sample of castor oil (perhaps impure) was miscible in all proportions with gasoline at a temperature of about 20 deg. C., while the other four at that temperature formed two layers for mixtures containing more than 50 per cent by volume of gasoline. When more than half of the volume was castor oil, a homogeneous solution was formed. When gently warmed on the steam bath, all of the mixtures became homogeneous solutions. Kerosene mixtures behaved similarly to gasoline, except that not quite as much kerosene could be dissolved in castor oil.

Since it is very unlikely that any oil would be kept in use after it had absorbed its own volume of fuel, and since even in a cold engine when less than 50 per cent of gasoline is present a homogeneous mixture is formed, it is evident that under normal conditions no difference is to be expected between the behavior of castor and mineral oils so far as dilution by fuel is concerned.

A Leak in Sales Expense

USE of old, incorrect lists for direct mail work is an important source of waste in automotive merchandising. It is common knowledge that there is a rather rapid turnover among automotive retailers, yet this fact often seems to be lost sight of when direct mail work is being done by manufacturers of cars, parts and accessories.

Lists become inaccurate, not only because of actual dealer and repair shop mortality, but also because of changed addresses, changed character of business and similar variations. To get the highest efficiency for mail-order work in the automotive retail field it has become almost necessary to use a stencil service which records all changes from day to day.

In 1923, in a retail automotive trade list of 97,548 names, for instance, there was a total of 134,278 changes. These corrections included the addition of 41,376 new names, the dropping of 31,155 names of firms going out of business, and the balance was made up of changes in ownership, character of business, etc.

The real cost of a list of names cannot be computed by dividing the sum paid for the list by the number of names it contains. The divisor must be the number of live names and this number can be kept relatively high only by constant checking.

Profits Are Better Than Records

THE automotive industry as a whole has been inclined to look on 1923 with its tremendous production record as a remarkably good year for everybody in the business. The volume of cars turned out, the huge sums paid in taxes, the stupendous total of raw material purchases all combined to make last year look like a winner in every respect and, consequently, to cast a shadow over the smaller statistics which must be used to tell the story of 1924.

But "things aren't always what they seem." Close examination of detailed facts indicates, to begin with, that last year was responsible for a good many of this year's troubles, and that the profits which its huge production brought to the trade should be charged also with some of the losses which same huge production made necessary this year. Moreover, a good many manufacturers didn't actually do so well in 1923 as examination of total production figures alone might indicate.

Registrations are a better guide to progress in the long run than is production. The registration compilations for the various States show quite accurately what sort of progress really is being made by a given car. The detailed registration figures for thirteen Southern States recently issued by the *Southern Ruralist* bring out some interesting facts along this line.

They show, among other things, that despite the very general talk about strong demand and big production, a good many cars failed to make material registration gains in these States, while a very substantial number recorded healthy decreases. This condition was not the result of lack of buying in these States in particular, as the total figures for the area under discussion compare well with those for similar territories in other parts of the country. It does mean that the gains were accounted for by a relatively small number of companies, while even during what has been considered a period of great prosperity some makes failed to go forward at all—and some of them are names which have been well known in the trade for many years. In Alabama, for example, where the total registrations on Jan. 1, 1924, were about 29,500 ahead of Jan. 1, 1923, Ford accounted for 22,379 of the total gain. Ford's gain in Arkansas was 18,183, while the total increase was just under 22,000.

It is natural that the Ford increase numerically should exceed others by a considerable margin, but the figures are given to show that totals in themselves may mean much or little as regards the prosperity of an individual company. Many other makes of cars recorded substantial gains, but the fact remains that prosperity.

Too much planning has been done in the past purely on the basis of total statistics and not enough on the basis of relative figures and comparison of trends. The only useful purpose of statistical data in the end is to provide individual companies with some basis on which to plan their own future activities in merchandising, production and finance. The relation of the particular company to the industry as a whole and to its own past performances must be considered carefully in making such plans.

It is too early to make definite predictions, but 1924 and 1925 may conceivably turn out to be better years than 1923 when all the returns are in and when the proper measuring scale is applied. When all is said and done, the automotive industry is seeking profits for the individual companies which compose it. The goal is not new records of production; new records in consumption of raw materials; or new records for cars shipped from the factory. The automobile industry is in business—not in a race. Profits—not speed—is its aim.

Oil Condition Affects Engine Wear

RESEARCH and development work calculated to solve the problems introduced by fuel dilution of crankcase oil now have reached a point where tangible results are being secured.

Engine wear is greatly accelerated by using a lubricant which contains abrasive sediment and sufficient fuel to materially decrease viscosity.

Wear is less rapid if either dilution or sedimentation is avoided, but the presence of either sediment or diluent is apt to accelerate wear.

Use of the carbureter choke is the cause of much fuel dilution of crankcase oil. Chokes should be eliminated or means taken to minimize their ill effect.

Water in crankcase oil is almost certain to result in corrosion if the fuel used contains sufficient sulphur to get into the crankcase and form sulphuric or sulphurous acid.

Higher cylinder wall and crankcase temperatures than are common, especially in winter, appear to be desirable from nearly every standpoint. Water does not enter the crankcase in considerable quantities if cylinder wall temperatures exceed a temperature of about 110 deg. Fahr. and slightly higher temperatures practically eliminate fuel dilution of crankcase oil.

Air cleaners which effectively remove dust and means for keeping the crankcase oil clean and free from fuel and water are worthy of serious consideration if engine wear and corrosion are to be minimized. Thermostats and evaporative cooling systems designed to maintain reasonably high jacket water temperatures are among the items which should not be overlooked if engine life is to be increased.

These important lessons were brought home by the recent S. A. E. meeting. They should be reflected in better design and will be if automotive manufacturers and engineers are awake to their opportunities.

SOME CITIES REPORT IMPROVED SALES

JUNE was a "clean-up" month for dealers in most sections of the country. Business showed some improvement in many areas but fell off in others. Trading-allowances given by factories again have made their appearance and dealers are using them to provide what virtually amounts to bargain sales in an attempt to clear their floors for new models which are scheduled for announcement in the next few weeks.

What the ultimate effect of this practice will be remains to be seen; its immediate effect has been to move new cars. In this work it has been aided by the weather, which finally has taken on some of the pleasant aspects usually common to it at this time of the year.

Out of reports from various sections of the country, about seven indicate that June business was better than that of May; little change is recorded in two or three, while conditions are shown to be worse in about four areas.

Dealers' opinions about the effect of new models on sales vary directly in accordance with the number of unsold cars they have on their floors at the present time. As retail sales throughout the country are spotty, so are local markets. There are extremes of prosperity and of poor business among dealers within individual towns in many cases.

Taken by and large, however, stocks of new cars in dealers' hands were reduced materially during June and the retail trade is in a slightly better position than it was at this time last month. With factory production some 15 per cent less in June than it was in May, the entire automotive business seems to be on a sound basis, ready to go forward conservatively in the production of new models and in the disposition of used cars.

Conditions in chief distributing centers as reported by correspondents of AUTOMOTIVE INDUSTRIES are as follows:

Conditions Throughout Country Generally Are Spotty

Chicago

CHICAGO, July 1—The past month has been one of the hardest periods through which many local automobile dealers have gone in some time. There was a further recession of sales and strenuous efforts were necessary to overcome sales resistance. Weather conditions have persisted with disappointments, the long awaited opening of summer seeming on several occasions to be on hand, only to step back and out of the picture after one or two warm, sunshiny days.

Dealer stocks in the Chicago district have been worked down somewhat in the past month but not to a satisfactory extent. It is generally expected that bringing out new models will serve as a stimulus to sales, more or less, especially where the new models offer something distinctively different that will provide talking points for salesmen.

Dealers who are well loaded with 1924 models, however, even though granted special concessions by factories in order to facilitate the movement of 1924 models, would much prefer not to see new models come on the market until they have a better chance to clean out present stocks.

Used cars are not moving so fast as they did. When the new models come in it is expected there will be a drop in used car prices and that business in this division will improve as a result.

Boston

BOSTON, July 1—Motor car sales in New England show that business is now improving materially. Dealers in the outlying sections have been sending in orders to the distributors fairly consistently for the last few weeks. And in some cases the distributors have been working out a system of calling up the dealers by telephone to get reports.

From reports gathered through wholesale men out in the territory sales throughout New England for the first five and a half months have been better than a year ago. What first seemed to be a general slump has not developed entirely. There has been a check to the drop, and now with other sales coming along the totals are better than a year ago. In Boston early buying and bad weather slowed up sales, while out of town a late spring reflected itself on business.

From now business is expected to continue along consistently. Dealers do not expect a big rush, even with warm weather. But they are feeling the trend of buying from what warm weather has come along.

New York

NEW YORK, July 1—So far as Metropolitan New York is concerned the month of June was no better than May, although in the latter half business picked up following the arrival of seasonal weather. The situation perhaps might best be described by the single word "spotty," for while there were several makes which did exceptionally well, including two of the higher priced divisions, yet in the main others were complaining of slow business.

As one man expressed it, New York did a big business in the early part of the year because of intensive work on the part of the dealers and long allowances on used cars. In consequence, sales that ordinarily would have materialized in June and July already were made in the first quarter.

The first half of the year, averaged up, has been good, although hardly comparable with the same period in 1923. If this comparison did not have to be made with a record breaking era, it is likely that everyone would agree that 1924 business so far has been "fine."

It looks better for July, with the coming in of new models.

Denver

DENVER, July 1—Trade conditions in the Denver territory were unusually spotted, erratic and disappointing for June, although not gloomy. It was the best month in the history for a few dealers and the poorest for others, with sales ranging from 45 per cent to 50 per cent above a year ago. The average probably is 10 per cent under and also slightly below May.

Political uncertainty and too much new model talk are blamed for the unexpected slowness and dealers handling cars without an annual model change are averaging better than others, while lines in which the first price increase since a year or more ago are predicted also as moving well.

Hot weather is aiding sales mainly in higher altitudes where snow is clearing and roads are improving. Four favorable factors are: Exceptionally brisk used car sales especially by Green Seal dealers, less wild trade allowances with more educating of owners to drive cars longer, more accessory selling by car dealers and a majority of dealers having stocks fairly cleared for new models.

Columbus

COLUMBUS, OHIO, July 1—While sales have been about 65 to 70 per cent of last year, dealers and distributors in Columbus and central Ohio territory have been watching their buying more closely, with the result that, generally speaking, stocks are pretty well cleaned up.

Some dealers have heavy stocks, but most of those handling lines which usually come out with yearly models about the middle of the year are in shape for the change. The warmer weather which has prevailed for the last few weeks had the effect of stimulating sales.

(*Conditions in other cities on page* 73)

OUTPUT LAST MONTH MAY TOTAL 265,000

Would Put 6 Months' Figure at 2,017,156

This Is Slightly Less Than the Production for Corresponding Period in 1923

NEW YORK, July 2—Directors of the National Automobile Chamber of Commerce will not meet until July 16-17 at Buffalo and consequently the usual estimate of the previous month's production of cars and trucks is not available at the present time.

A careful unofficial survey made by representatives of the Class Journal Co. shows, however, that June production is about 15 per cent under May. This would mean the manufacture of about 235,000 passenger cars and 30,000 trucks, a total of approximately 265,000, compared with May's 312,813. Ford production is estimated to have been 145,000.

Truck production has not been so affected as has that of cars and it is estimated that the final figures on June will show about 30,000 as compared with 33,374 in May. Trucks have been running steadily all of this year.

The last ten days of June are said to have shown a slight increase in car production, caused by the introduction of new models which caused some factories to get busy. This new model phase is expected to bring the July count above that of June, though this may be offset to a large extent by decreased output on the part of those concerns which are not changing models.

1,823,501 Cars Produced

This unofficial survey of June's work in the factories gives a line on production for the first half of the year. In the first six months of 1923 the production of cars and trucks totaled 2,031,093, while in the same period in 1924 the count is approximately 2,017,156. Of this, the 1923 total is divided into 1,830,916 cars and 200,177 trucks, while in 1924 cars figure 1,823,501 and trucks 193,655.

From this, however, it must not be expected that 1924 will equal 1923's 4,086,997, for in the second six months of last year production was comparatively heavy, with 297,371 in July, 314,399 in August, 299,928 in September, 335,023 in October, 284,923 in November and 275,439 in December.

Conditions are far different this year than last. In 1923 the industry made a slow start, turning out 798,393 in the first quarter, whereas this year the first three months showed 1,075,204. April followed with 373,139, then came the drop in production, May showing a decided falling off, while June was 15 per cent under May. In 1923, though, the middle months of the year found the industry going at almost capacity and the slow down did not come until the last two months.

It is believed that for the balance of the year the industry will move cautiously, sensing public demand and trying to meet it rather than endeavoring to run to capacity. It is pointed out that even with the present slow months, production is above what the statisticians figure to be normal and that 1924 suffers in comparison with 1923 only because the latter was a record-breaking twelve months.

DEALERS REPORT TIRE STOCKS ON DECREASE

NEW YORK, June 30.—Reports received by the National Tire Dealers Association indicate that the retail end of the business is in fair shape. This conclusion is arrived at by President George J. Burger after studying the replies to the association's questionnaire sent out May 31 to dealers in 26 States.

The survey, Mr. Burger finds, shows a decided decrease in inventories of tires and tubes on hand. Sales, he says, have shown a healthy increase, considering the adverse weather, while the general business conditions reported by the members are "about fair."

Cleveland Retail Trade Increased Sales in June

CLEVELAND, July 1—Dealers in this city were able to increase sales of new cars during the summer weather that prevailed in June. Some dealers, who were able to put across striking and unusual sales plans, sold more cars than they did last year in the same month. Other dealers representing manufacturers that put their 1925 models on the market in June, enjoyed a good run of business, with sales reaching pretty close to what they were in the same month of 1923.

The retail automobile business in this city is in better shape than are other retail lines. Dealers still selling their 1924 models complain that the early appearance of 1925 models has acted adversely on sales, as prospects do not want to invest in a 1924 car that is soon to be a year old. Stocks are moving, but not so swiftly as they did last year in June, and consequently dealers will not be able to take on the stocks of new models that they did last year. The banks, however, have helped to keep down the dealers' stocks, and there does not appear to be a great surplus of 1924 models.

Bank Makes Report on May Conditions

Federal Reserve in Chicago Finds That Stocks Were Reduced During the Month

CHICAGO, June 30—In its report of business conditions in the Seventh Federal Reserve District for the month of May the statistical division of the Federal Reserve Bank of Chicago makes the following comment with respect to automobile sales:

Dealers and distributors of the Middle West report a smaller volume of passenger cars sold at wholesale and retail during May in comparison with April, and with May a year ago. As was the case in April, the number of new cars in the hands of dealers was less than in the preceding month, while the year-to-year comparison shows a continuation of the large gains shown in the past months.

Sales of used cars during the month also receded from April, as well as from May, 1923. Fewer used cars were in the hands of dealers on May 31 than on April 30, but the number considerably exceeded that of a year ago. Used cars on hand May 31 represented 111 per cent of the May used cars sold.

Reports received by the bank from Chicago warehouses, it was stated, indicated some improvement in the movement of cars to consumers and a reduction of cars in storage as a result of slowing down in replacements from the factories.

Employment Curtailed

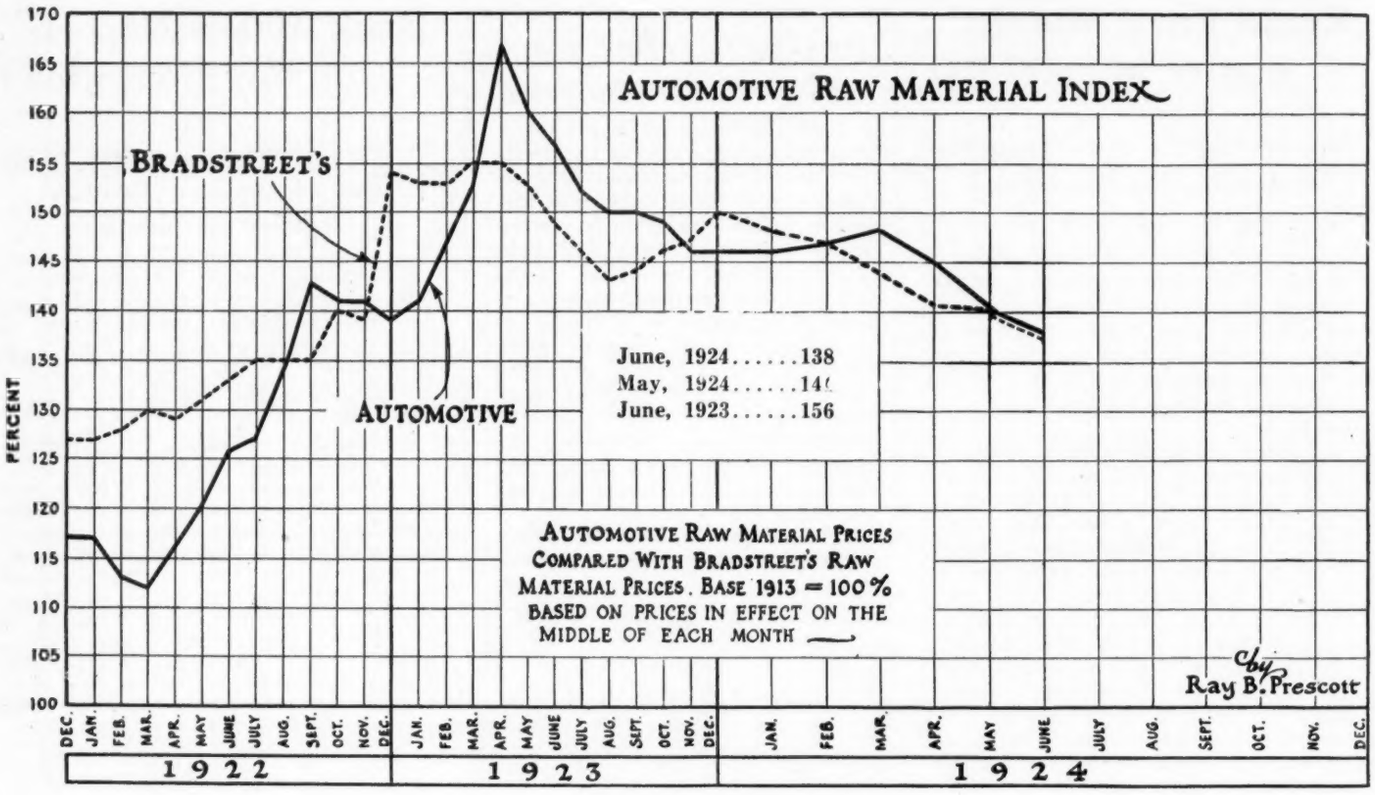
The bank's survey of industrial employment indicates that such employment in the district on the whole was curtailed somewhat more than in Illinois, based on a report by the Illinois Department of Labor. The bank puts the district's employment slump at 3.5 in numbers.

This might be taken as substantiation of a contention that while industrial conditions in Illinois and the Chicago district are caught in the general slowing down of operations, this immediate section really suffers less than some others. In the vehicle division, which includes automobile factories, the bank's reports indicate an employment slump in May as compared with April of 2.9 per cent in numbers and 7.8 per cent in earnings.

DANTZIG FAIR DATES CHANGED

DANTZIG, June 5 (*by mail*)—The Eleventh Dantzig Fair, which will have a considerable section devoted to automobiles, will be held Oct. 2 to 5, instead of Aug. 3 to 6, as was previously announced. It will be held under the direction of the Danziger Internationale Messe, Messegelande Haus Ostende. Fernsprecher 5287, 5291, Dantzig.

PRICES OF MATERIALS QUOTED LOWER



Weather Conditions Continue to Exert Strong Influence

Milwaukee

MILWAUKEE, July 1.—Brighter prospects characterize the motor car sales situation in Milwaukee at this time, although there continues to be a tendency among car buyers to concentrate on a few chosen makes.

Dealers of popular priced cars catering largely to wage earners are not very optimistic about the business they expect to do this year. Employment conditions, while said to be better than in many cities of similar size, are not such as to warrant the investment of the workman's savings in motor cars, many laborers, and even skilled workers, fearing that they may be out of work before many more weeks. This situation is expected to adjust itself with the improvement of the national economic conditions, however.

The reaction of dealers to the advent of new models differs. Those who have been doing a large business are confident that new models will stimulate sales to an even greater volume, while a few who have been accumulating an overstock in the past feel that new models will make the old ones a burden on their hands.

In general, it is felt that the only trouble with the business at the present time is that the weather has retarded the season by about thirty days. Confidence that the summer slowup will also be postponed by a month is practically unanimously expressed.

Baltimore

BALTIMORE, July 1—A survey of the trade in the Baltimore territory shows that for the most part the dealers are moving their stocks and are making money. Considerable complaint is being heard in many other lines of business, but those closely associated with the automotive trade declare that generally speaking the dealers in this industry are satisfied that their business is as good as could be expected.

Although the cold, rainy weather this spring was felt to a great extent, when the warm weather did come its arrival was reflected on the trade to a marked extent. Immediately with the coming of warm weather there was a noticeable increase in the demand and this demand is keeping up, many dealers report. The business has been better than some dealers had anticipated.

The used car situation also is fairly good, the weather conditions helping to move stocks much more satisfactorily. As in the case of new cars, the demand for used cars with many of the dealers is better than had been expected a short time ago.

Toledo

TOLEDO, July 1—Dealers in the Toledo territory during the last few weeks have whipped sales up so that they are almost on a par with last year. For some time they have been running about 9 or 10 per cent behind last year, but the outlook for July is that the 1923 gait will be resumed. Good weather has had much to do with sales, dealers report.

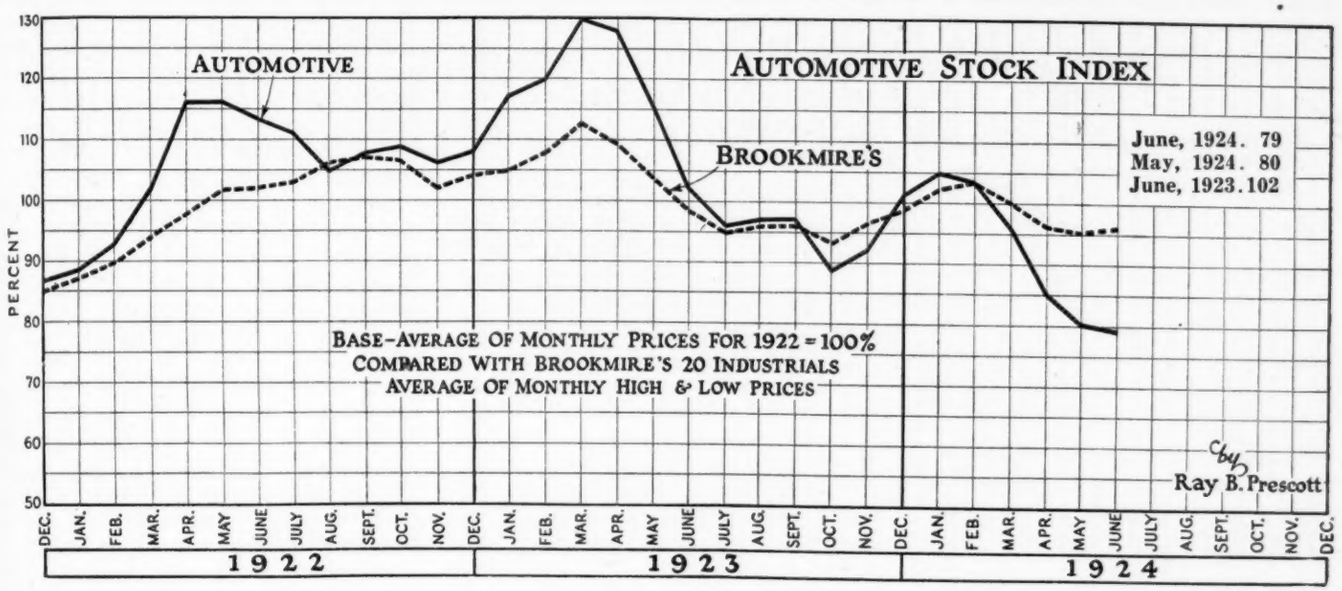
Dealer stocks are being decreased in good order. A few dealers are overloaded due to rather excessive stocks piled up in the early months of the year. On the whole the situation is rapidly getting better and the majority of dealers will be cleared of stocks by the time new models are brought out.

Used car sales have about held their own and the situation in Toledo is very good. Dealers have not accumulated stocks beyond their means to sell except in one or two cases.

Indications are that the dealer field will narrow down some this year with a few less dealers at the end of the year. The old-line dealers with strong business records are going ahead now while some of the newcomers appear to be losing hold and apparently taking a course that will land them out of the field.

(*Conditions in other cities on pages* 84 *and* 85)

SLIGHT DROP IN AUTOMOTIVE STOCKS



New York Exchange

	Apr.1	Apr.28	June 28
Ajax Rubber	6¾	6	6¼
American Bosch	26½	24¾	31½
American-La France	10½	10¾	10⅛
American-La Frnace pfd.	..	96	92¼
Case, J. I.	..	⅝	19
Cast, J. I. pfd	49	..	45½
Chandler	48⅞	47	45½
Continental Motors	6⅞	6½	6¼
Eaton Axle & Spring	17	17½	12⅝
Electric Storage Battery	57	57	56
Emerson-Brantingham	1½	..	1¼
Emerson-Brantingham pf.	10	..	1¼
Fisher Body	205½	209	180
Fisher Body pfd	99	99½	99
Fisk Tire	8¼	6½	6½
Fisk Tire pfd	54½	47½	40¼
Gardner	..	5	4
General Motors	14¼	14	13⅛
General Motors pfd	..	83	82½
General Motors 6%	81¾	83	82½
General Motors 7%	95	97½	94
Goodrich, B. F.	20¼	20½	19⅜
Goodrich, B. F. pfd	71¼	72	74
Goodyear Tire pfd	43⅛	42⅝	46⅝
Goodyear Tire pr. pfd.	90	91½	92¾
Gray & Davis	5¼	4¾	5
Hudson Motor Co	26¼	23⅞	23¼
Hupp Motor	13⅝	12⅞	12
Indian Motorcycle	19½	20½	17
International Harvester	83	85	88⅛
Internat'al Harvester pfd.	..	107	107½
Kelly-S Tire	17	15⅝	11½
Kelly-S Tire 6% pfd	55	52½	40
Kelly-S Tire 8% pfd	45¾	51	31½
Kelsey Wheel	86	81	78
Kelsey Wheel pfd	..	..	105
Keystone Tire	2	2	1⅝
Lee Rubber	11¾	10⅝	8½
Mack Truck	81	81	88⅛
Mack Truck 1st pfd	96¼	..	98
Mack Truck 2nd pfd	88	87	90½
Marlin-Rockwell	12¼	11½	11
Martin-Perry	35	35½	33¾
Maxwell Motors A	43⅝	42¾	49½
Maxwell Motors B	11⅞	11¾	12⅞
Moon Motors	23⅛	20½	20
Mullins Body	10	..	11
Mullins, pfd	..	..	..
Nash Motors	100¾	100¾	104
Nash Motors pfd	99¾	99	99
Ohio Body & Blower	1¾	..	1¼
Packard	10½	10	10½
Packard pfd	93¼	89½	84¼
Parish & Bingham	14⅞	15¼	15
Pierce-Arrow	8⅞	8⅛	8¾
Pierce-Arrow pfd	21½	21½	24
Pierce-Arrow pr. pfd	43¾	..	61
Reynolds Spring	15	14⅞	11
Spicer Mfg. Co	13	12	8
Spicer Mfg. Co. pfd	85	..	..
Stewart-Warner	77½	73¾	65⅜
Stromberg Carbureter	64½	64	61
Studebaker	93¼	85⅞	34
Studebaker pfd	111	..	109⅜
Timken Roller Bearing	36	34⅞	33
U. S. Rubber	30¼	29⅜	27¾
U. S. Rubber 1st pfd	79½	79	76¾

Detroit

Auto Body Com	..	1¼	..
Columbia Motors	½	9/16	25
C. G. Spring Co	7	5⅛	..
C. G. Spring Co. pfd	6	6	..
Continental Motors	6⅞	6¼	6⅜
Edmunds & Jones	39	34	..
Edmunds & Jones pfd	92½	..	..
Federal Truck	22	..	..
Ford of Canada	455	488	408
Gen. Al. & Brass Mfg. Co.	14¼	13¼	12¼
Hayes Mfg. Co	1⅞	1¾	..
Motor Products	65	..	..
Motor Products pfd	48½	..	..
Motor Wheel	9½	9	..
Packard com	10¼	10⅛	10¾
Packard pfd	93¼	..	..
Paige-Detroit	15	13⅜	12½
Reo	16⅛	17⅛	15½
Timken Axle com	5	5½	4⅜
Timken -D Axle pfd	..	75	..

Chicago

Bassick Alemite	32½	30½	..
Borg & Beck	..	24¼	24
Continental Motors	6¾	6½	6½
Earl Motors	..	..	..
Eaton Axle & Spring	..	..	..
Gill Mfg. Co	..	..	..
Hayes Wheel	..	..	..
Hupp	..	12½	12
McCord	32	..	34½
Reo	16⅛	..	..
Reynolds Spring	..	..	..
Stewart-Warner	77¼	72⅞	65¼
Yellow Mfg. Co	81¾	57	53½

Philadelphia

Electric Storage Battery	58	57	..

Cleveland

Firestone	68	66	..
Firestone 6%	96	93½	95½
Firestone 7%	87	86	..
Goodyear	10	10	9¾
Goodyear pfd	..	43	..
Jordan pfd	..	90	..
Miller Rubber	65	61	65
Miller Rubber pfd	97	97	93
Peerless Motors	18¼	20	17
Stearns F. B.	15	14¼	13¾

Boston

Gray & Davis	..	4¾	5½
Greenfield Tap & Die	13¾	14	..
Hood Rubber	46	..	..
General Motors	..	..	..
Fisk Rubber	..	..	..

New York Curb

Bassick Alemite	32½	..	..
Cleveland Motors	19¼	18	16¾
Durant Motors	20¾	18½	13¾
Durant Motors of Ind	..	..	..
Dupont Motors	1	..	2⅞
Edmunds & Jones	..	..	..
Ford of Canada	456½	454	..
Goodyear Tire & Rubber	10	10	10
Hudson pfd	20⅞	26	35⅞
Jordan Motor Car	26½	..	..
Motor Products Corp	..	..	..
Motor Products pfd	..	47½	..
Paige-Detroit	15½	13¼	..
Peerless	19	20	..
Reo	16¼	17¼	15½
Stutz Motors	8	8	7¼
Standard Motors	2⅞	2½	..
Timken -D Axle	..	5⅜	4¼

Our Industry Today—

Activity Among Car Producers Will Hinge Largely on Condition of Dealers' Stocks and Disposition of Public to Buy

NEW YORK, June 30—The volume of automobile production in July will hinge largely on the condition of dealers' stocks and the evident disposition of the public to buy and absorb factory output. The feeling is general throughout the industry that operations during the month should show a relatively strong upward trend from the marked recession in June.

This is based largely on the fact that while nearly all plants in the leading automobile producing centers were operating to some extent during the last few weeks, operations in general slackened perceptibly. In nearly all instances the only cars that were made were the special models of recent introduction.

Reports indicate that the slowing up in production has been effective insofar as it has given dealers a better opportunity to move stocks without feeling under the necessity of taking output at the same time. Moreover, there is a disposition on the part of both distributors and dealers not to take more cars until the stocks on hand have been depleted. More buyers, restrained by backward weather, have entered the market but buying continues somewhat hesitant and stocks up to now have not been reduced in line with anticipations. Sales efforts from now on will be as strong a factor in the industry as actual manufacturing operations.

Some Gain Looked For

Very few manufacturers feel that during the remainder of the summer plant schedules will assume a position comparable with that of the early part of the year although there will be some gain as production begins on new models. This viewpoint, however, may change as the retail horizon brightens and business conditions in other lines of activity present a better tone. There is no question that the industry, both as to sales and production, has been and continues to be above the level of normal business activity and is maintaining the lead it has kept for months.

Should the rest of the summer and early autumn prove as slow as now expected it is not improbable that conditions will be so righted by October that the industry will be warranted in returning to high production marks in the last three months of the year. It would not be surprising, if this should take place, to find the final quarter outstanding in the number of cars produced and taking a place in production records somewhere near the earlier months of the year.

Manufacturers, however, will follow a conservative pace until the outlook is clearly defined and they have actual facts on which to base their operations.

Cleveland Reports Better Employment

More Men Put to Work—Factories, However, Are Operating Conservatively

CLEVELAND, June 30—The most hopeful sign for increased demand for the products of automobile and parts manufacturers in the Cleveland district during the last week, was found in the further upturn in available employment. Taken through the industry, employment is not yet up to normal of that for 1923, but employers state that it is rapidly climbing back to the best point reached this year, in the late spring months.

Such firms as Fisher Body continue to increase their working forces, taking back as far as possible those men who had been previously laid off. The older automobile companies are gradually bringing back to work their men who had been temporarily dropped during the slack of 30 to 45 days past.

Anticipating Busier Times

Some of the more recent companies are still operating with from 40 to 60 per cent of the factory forces, which they had either formerly employed or estimated would be required to meet production demand for this season.

A survey of the major plants in the Cleveland territory shows about an 8 per cent betterment in employment for automotive and parts plants for the past week, as against the run for the previous seven days. Much the same average is reflected through the statements of both private and public employment agencies.

Coming as it does, just prior to mid-year inventory times, the improvement in demand for this class of factory workers, is said to indicate that the automotive industry will fulfill its optimistic predictions for July production. Assuming that this is accomplished during the next 30 days, manufacturers here point out that the average output for the factories in the Cleveland district will have reached the figures attained for the same companies during the first seven months of 1923.

Coincident with any sharp downturn in the sales of new cars, experience shows that there is an increase in the turnover of distributors of automobiles. Seven of the leading manufacturers of automobiles in this district state they have experienced no difficulty in holding their established distributors throughout the country. In fact more than the usual number of applications for distributors' franchises from persons of unquestionable financial standing have been received recently, according to officials of four companies.

Retail Situation

Notwithstanding the evident signs of betterment in the automotive manufacturing field, Cleveland retail distributors of both parts and passenger cars of all kinds, are holding to a conservative policy in regard to their stocks. There is a marked tendency to order on the basis of a "hand to mouth" policy.

This is accounted for, dealers report, by the belief that the buying sentiment of the nation can not yet be definitely ascertained. People here, and in other large communities as well, are still undetermined on just how large a personal budget may be allowed safely for the balance of 1924. The majority of potential automobile and parts customers will not be settled on this until the political atmosphere is better cleared, it is asserted.

Summed up, the situation for the Cleveland district, during the last week, may be said to have been one of cautious, conservative improvement. This applies as well to the distributing as to the manufacturing end.

Makers Wait July Developments

Detroit Continuing on Lower Programs

Increased Production Likely to Follow Slowest Operating Period of Year

DETROIT, June 30—General factory operation in this district has continued to show reduction during the closing period of the month, due in some respects to the general slowing down in business, but to a large extent due to the approach of the inventory period. It is expected, however, that the closing week of June and possibly the early part of July will prove the slowest period of the year, followed by generally increased operations throughout the industry.

Production for June will show a sharp drop from the May figures, and July, owing to reduced operations in the early weeks is not expected to reflect improvement, but the latter part of that month will find operations on a resuming basis. Shipments from factories in June have shown a gradual recession from the first week as opposed to usual gains throughout the month, and the month is interspersed with days when some factories show no shipments at all.

Dealer Stocks Lower

The most encouraging part of the entire industrial situation is, however, that dealer stocks are getting lower all the time and it is certain that these will all be cleared away within the near future. The retail buying situation has remained good throughout the first six months of the year and while much lower than had been counted upon, has been steady enough to take up stocked cars after the factories reduced operations.

Announcements of new models now starting give definite indication that the stocks of former models have been pretty well cleared away. Factory executives have been in close touch with the retail field in preparing for the new models and are only letting them go now because they are certain that the majority of all previous models have been cleared from the dealer establishments, and that the market is ready for the new offerings.

Largest stocks of cars have been in the hands of dealers selling the low priced lines. Ford, with sales in June holding up to the average of earlier months, would have had these down to the vanishing point by the month end. June deliveries, however, did not come up to expectations in the earlier weeks with the result that dealers will have a few more cars starting July than anticipated but scarcely enough to be called stocks.

Several other makers who in addition to stocking dealers heavily also warehoused a large number of cars, have been making definite headway in reducing their inventories, and are now drawing on the warehouses to meet dealers demands. In these cases where warehoused stocks supplemented those the dealers had, the factories were more sharply affected in the general curtailment and will be the last to respond in swinging back to normal operation.

The Week in the Industry

TALK about lower priced closed bodies began several years ago. Some dreamer at that time predicted equal prices for closed and open models at a future date. The dream has come true. Hudson, which started the utility closed car movement with the first Essex coach, has dropped the price of the Hudson coach to $1500, thus bringing it level with the seven-passenger phaeton model—just another proof of the fact that the automotive industry usually achieves what it sets out to do.

Henry Ford is about to give a real boost to commercial aviation by building and equipping an aviation landing field at Dearborn. The new field is to be an elaborate affair, according to the announcement, which may serve as a model for further developments along the same line. Mr. Ford's interest in aviation centers specifically around the Stout Metal Arplaine Co. and the Aircraft Development Corp, but he seems about to take an active part in encouraging commercial aviation development in general.

Mystery about what C. W. Nash was going to do with the Mitchell plant has been largely cleared up. He has incorporated the Ajax Motors Corp. with $3,000,000 capital stock and the unofficial story goes that he will put on the market a new light automobile which will be built in the old Mitchell factory. H.C.S. is about to broaden its field as well. It will begin to build a taxicab in the near future.

Automotive exports took a slight drop in May as compared with April, but ran ahead of May, 1923. Tire exports were the only ones to go up in May.

Chicago Holds Back on Output Activity

Little Likelihood of Upward Trend in That Territory for Some Days

CHICAGO, June 30—Just what direction automotive production in this section will take in the near future is a question for which it is impossible to find an answer in the Chicago territory. There is no doubt but that there was a further tapering off during the month of June which was fully up to expectations of 30 days ago. As the general tendency has been downward for some time, it is not unlikely that this course will be continued for an indefinite time.

The past week seems to have contributed no material change to the situation. It was productive of some cheerful reports here and there and a like number that were less enheartening. Consumption of automobiles and many classes of automotive products is weak. Automotive production consequently is holding back, hopefully awaiting enlivened retail activity.

Industry at Slow Pace

In the immediate vicinity of Chicago a big share of industry is operating on a reduced basis, factory time being either cut down to the point of requirements or forces being diminished. Not a few plants are running on as low as 60 per cent of capacity or normal operation. Business is slow in most lines of industrial enterprise.

Body building is one of the exceptions to the rule, the demand for bodies being stimulated by the demand for new designs in the 1925 passenger car models. Body builders are realizing a good outlet through this avenue and should go through the rest of the year in good shape. The coach and cab demand continues strong, this industry being perhaps in as flourishing a state as any branch of local manufacturing.

Automobile producers are cooperating with distributing agencies and dealers in an effort to clear away old stocks as completely as possible for new models. Future schedules will be built upon safe foundations by automobile factories, ample to meet requirements of the buying public, yet, insofar as it can be guarded against, not carried to the point of overproduction.

Campbell to Widen Durant Sales Field

New Vice-President to Strengthen Dealer Organization and Open Up Territory

DETROIT, June 27—With his appointment as vice-president of Durant Motors, Colin C. Campbell, formerly widely known as a General Motors sales executive, has undertaken as his first duties the building up of the sales and dealer organization handling the Star and Durant.

Factory capacities on these two cars approximates 1200 to 1500 cars daily at the plants in Elizabeth, N. J., Lansing, Mich., and on the Pacific Coast, and Mr. Campbell said, while on a visit to Detroit this week, that he has started work on building up the present dealer organization to a point where it can readily market this production.

Will Enlarge Dealer Force

There is need for a general strengthening of the present dealer organization and there is considerable territory to be opened up. Within the next few months Mr. Campbell is planning to bring many new dealers into the group and to close up much of the present open territory. District offices will be opened at important cities in the country through which sales headquarters will keep in constant touch with the dealers.

Sales of none of the cars making up the Durant line will be coupled up, according to Mr. Campbell, but so far as possible he will adhere to the policy of establishing individual representation for each car. This policy will be carried out especially in the merchandising of the Star, he said.

By establishing individual dealer organizations for each line better credit accommodations will be afforded. Each dealer will be able to concentrate his efforts and the efforts of his salesmen to moving this particular car. Better service will also be afforded.

Territories to Be Analyzed

Regarding general policies on the extent of dealer territories, number of dealers, etc., Mr. Campbell said that these would be based upon territorial analysis, and along lines similar to those he has worked out formerly. Dealers will be placed in sufficient number to get all the business that can be obtained in given territories, he said, but there will be no crowding.

Territorial analysis will establish the potential market as indicated by economic conditions and personal wealth of residents in given districts rather than by the number of residents. "Everyone that walks," said Mr. Campbell, "must be regarded as a potential buyer of an automobile until it is proved that he has no money and no prospects of getting any."

"Districts will be found under analysis to have certain absorption possibilities for cars in all price classes. This will vary," said Mr. Campbell, "according to the wealth of the inhabitants. It remains then to establish enough dealers in each district to get as much of this potential business as can reasonably be expected."

The establishment of dealers in cities will be based similarly upon what the analysis shows. Cities must be regarded, said Mr. Campbell, simply as a number of smaller communities which have grown together but each of which retains to a large degree its own trading center. Each of these presents an opportunity for a dealer to develop a large business without invading the other man's territory in the next community, though definite territorial lines do not have to be set.

Dealers should carry accessories as part of the general automobile business, said Mr. Campbell, relating his policy on these. This should be more to meet their customer's requirements than to push the sale of accessories. They should, however, buy these themselves according to their own judgment, through accessory makers and jobbers, and not from the car factory.

Mr. Campbell said a wide advertising campaign would be undertaken. In this connection he has engaged George Frank Lord as advertising manager, Mr. Lord having formerly been associated with Mr. Campbell in the merchandising of low-priced cars.

In taking over the development of the Star and Durant merchandising work, Mr. Campbell said that, responsible for sales, he would be in charge of the work on these two lines from design at the factory, to service in the hands of the owner. He is making this responsibility his own, he said, in carrying out his theory of the duties of the sales executive—"to know that the product is right, that it is sold right and that the owner gets everything that he is entitled to."

Elgin Sued for Salary; Receiver Is Appointed

INDIANAPOLIS, June 26—Elgin Motors, Inc., of this city was placed in the hands of a receiver here this week when suit was brought by Merton S. Black, works manager of the company, on a claim for $300 for salary. Judge Sidney S. Miller, before whom the suit was brought, appointed Ralph A. Young, a real estate agent, receiver. The action is said to be a friendly one. The complaint filed by Mr. Black alleges that the corporation is in debt in excess of $40,000.

The reorganized company was formed here more than a year ago by an Indianapolis corporation which purchased the stock of the former Elgin Motors Co. of Illinois. The company plant, the former factory of the Empire and other automotive concerns, was revamped for assembly production of the Elgin, and production jobs were shown at the last New York show. The factory has been inactive for a considerable time.

New A. A. A. Planning Its Biggest Meeting

Will Hold It in Detroit This Month, When Former Differences Will Be Buried

WASHINGTON, July 1—What is heralded as the greatest meeting of motor car owners since the inception of the automobile is scheduled July 7 and 8 at Detroit, when delegates gather for the first convention of the old A. A. A. and N. M. A. since consolidation of the two national bodies. Details have been announced here at the national headquarters of the new American Automobile Association.

Not only will this be the largest convention of its kind in the annals of organized motordom, it is said, but it will formally mark the end of the bitter warfare that has long existed among some of the country's great automobile clubs, many of which, already powerful and influential in their respective communities, will be even more so with the added strength of nation-wide organization.

Into this meeting will come, it is pointed out, the Ohio State Automobile Association bringing with it the Cleveland and Cincinnati clubs, now in accord after years of antagonism. Also Louisville and Detroit club representatives will shake hands across the table and will work together for the betterment of local and national motoring.

Too, Indianapolis and St. Louis, which have been at outs for many moons, will again meet in friendship, while Chicago and Baltimore will bury the proverbial hatchet.

Portable Drill Maker Answers 200 Creditors

MILWAUKEE, June 30—The A. H. Petersen Manufacturing Co., manufacturing the "Hole Shooter," an electric portable drill, used in automobile factories, garages, etc., has filed schedules in answer to involuntary bankruptcy proceedings instituted on behalf of 200 creditors.

The plant, built three years ago, was damaged by fire in December, and gutted by a second fire in April. A. H. Petersen, chief officer and owner, has been confined by illness several months.

Liabilities of $184,634 are admitted and assets of $309,353 claimed. The assets include an item of $125,000, representing insurance claims which remain unpaid pending completion of the investigation into the origin of the fire.

PAN-AMERICAN PLANT SOLD

DECATUR, ILL., June 28—The Pan-American Corp. grounds and buildings, representing an investment of $350,000, were sold at auction this week to J. M. Brownback for $30,000. He was the only bidder for the seven-acre tract which includes a modern plant with 1600 sq. ft. of floor space.

Balloons Permanent, Says Dunlop Official

Sir Eric Geddes Comes Here to Make Inspection of Company's American Plant

NEW YORK, July 3—Sir Eric Geddes, chairman of the Dunlop Rubber Co., Ltd., of England, is in this country, inspecting the American plant. He declares that Dunlop production in England is 50 per cent in advance of last year and that his company is producing more than 90 per cent of the British tires sold in England and about 50 per cent of all tires sold there.

Balloons, he thinks, are here to stay and 50 per cent of next year's English cars produced will be so equipped. There are about 20 per cent more tires being used in England than last year, he says, and the number of cars is increasing. Sir Eric feels that the Stevenson plan does not give the desired result, but he believes in its practicability.

Reconstruction Plan Opposed

LONDON, June 23 (*by mail*)—At a meeting of the Dunlop shareholders, convened to receive the directors' report and pass resolutions agreeing to the proposed reorganization of the company's capital in order to wipe off the deficit shown in the accounts owing to the losses of 1921-1922, the chairman, Sir Eric Geddes, announced that the Parent Tire Co., which holds the bulk of the Dunlop Preference shares, had notified its opposition to the reconstruction plan, so far as it affected its interests.

For that reason it was useless to attempt to pass resolutions, and it was agreed to form a committee representing all classes of stockholders to confer with the board of directors with a view to formulating an agreed plan.

As regards the accounts submitted, showing the results of working during the 18 months ended Dec. 31 last, Sir Eric considered that the stockholders had reason to be congratulated upon the great improvement evident in the position and operations of the company.

Sales Increase Reported

A net trading profit of £1,538,000 was shown, and it was stated that sales up to the present time this year had made a big increase in practically all markets.

Two years ago it was admitted that although Dunlop tires were fitted to the vast majority of new British cars, the replacement market was very largely in the hands of Michelin. This state of affairs no longer holds, and in confirmation of this Sir Eric said that a census of tires taken recently at the Epsom Races (Derby Day) showed that of 16,000 tires observed on cars of all nationalities nearly 50 per cent were Dunlops.

Sir Eric, referring to the American Dunlop Co., said that when it was decided to commence to operate that concern it was contemplated that deficiencies would be faced in the early years, but if the present progress in that direction were maintained the deficiencies would be for shorter periods than were originally expected.

He said that he would sail for America on June 21 to keep in touch with the American officials. As regards the initial loss of £383,000 sustained by the American company during its first year, that included payment of bond interest and certain non-recurring charges. The plant, it was claimed, was making tires of the highest quality, its sales were steadily increasing and the board felt confirmed by these facts in its opinion that the policy of persevering with this development would in the end be justified.

Good Factory and Dealer Organizations Are Required to Make Sales Efforts Successful

AN INTERVIEW WITH COLIN C. CAMPBELL,
Vice-President of Durant Motors,

By D. M. McDonald,
Detroit News Representative of the Class Journal Company

Detroit, July 3.

ORGANIZATION has been the keystone of success in sales of the first six months of the year, organization beginning at the factory and extending down through the ranks to the smallest dealer in the field, declares Colin C. Campbell, newly elected vice-president of Durant Motors, and one of the best known sales figures in the automotive industry.

Factories which have had the right kind of organization, which have had the right kind of merchandise, and which in addition had the proper plans for moving it and for meeting emergencies have not experienced any serious falling off in business in the first six months, some, in fact, showing gains over the same period last year, Mr. Campbell says.

There is no real reason why cars should not have been sold in as large volume by all companies this year as in other years, provided they were properly organized to do it. Taking the leading companies, says Mr. Campbell, mentioning six or eight, their business in the first six months has either gained or has equalled that of any year, simply because they were organized to meet conditions as they developed.

In a large sense he says it has been a question of the appeal of the car itself to the general buying public. We have seen this year, he says, several entirely new cars placed on the market which have developed practically volume business because they had appeal and because the factories had made proper plans for getting them before the public.

The appeal of the car, however, is strictly a part of the business of the sales organization at the factory, because they should be in a position to sense the trend of public tastes. The sales department above any other at the factory should be responsible for the production of the right kind of merchandise because they are closest to the firing line and should know what the public wants.

They are the ones who have to sell the cars and they should know the kind of goods that will meet the greatest public favor. With the right car the largest part of the battle is over, as the experience of the present year has shown, and this is credited with being a difficult year to sell.

Dealers handling cars that appeal popularly have not found it difficult to move them this year nor have they been obliged to make sacrifices to do it. They have made money in the early part of the year and are well equipped to go into the fall season and make a profitable period of it.

These dealers have been well organized and well instructed from the factory and they have built up a credit structure throughout the country which is the most important asset to any factory. The credit structure in the field, emphasizes Mr. Campbell, is more important than factory finances, manufacturing resources or factory selling ability, in determining the business that is to be done.

Considerable business has been transferred from one car to another in the first six months of the year, Mr. Campbell says, but he expressed doubt that any large amount of business had been actually lost. Total retail deliveries will show gains over previous periods. Business lost might have been held had the proper spirit of confidence been created.

Warner Gear Co. Obtains "Constantmesh" Rights

MUNCIE, IND., July 2—The Warner Gear Co. has completed arrangements for the manufacturing rights on the McCarrell Constantmesh Transmission, which will be made in the three-speed and reverse type in different sizes.

In conjunction with this transmission, this company has also taken the rights for the Randol mechanical gear shift, which is pre-selective at any position of the clutch pedal with which the shift is interconnected.

The transmission will be known as the Warner-McCarrell Transmission, while the gear shift, which may also be applied separately, will be marketed as the Warner-Randol.

Bus Merger Headed by Hertz Interests

Omnibus Corp. Formed to Take Over New York and Chicago Transport Systems

NEW YORK, July 2—The merging of two of the greatest bus transportation lines in the country—Chicago and New York—has been practically consummated in the formation of the Omnibus Corp., headed by the Hertz interests, and announced this week. It needs only the transfer of 51 per cent of the New York stock by Aug. 1 to ratify the deal arranged by the banking houses of J. & W. Seligman & Co. and G. M-P. Murphy & Co. That, it is said, is practically assured now.

The Fifth Avenue Bus Securities Corp., the New York Transportation Co. and the Chicago Motor Coach Corp. are the ones involved in the merger and will be brought together in the Omnibus Corp., which will be the holding company.

Companies' Operations

The Fifth Avenue Bus Securities Corp. now owns more than a majority of the stock of the New York Transportation Co., which in turn owns the entire capital stock of the Fifth Avenue Coach Co. and manufactures buses for use by its subsidiaries and for sale to others.

The Fifth Avenue Coach Co. owns and operates bus lines in New York. The third partner, the Chicago Motor Coach Corp., owns the stock of the Chicago Motor Coach Co., the latter owning and operating bus lines in Chicago and Cook County, Ill.

Unification, recapitalization and reorganization of these three units under the name of the Omnibus Corp. will permit of later expansion all over the country. New York and Chicago will be the national demonstration fields, where ideal bus service will be installed. Later, the Omnibus Corp. will expand, by investing either directly or through the securities of holding companies or otherwise, in bus lines in places where the demand for them is apparent, its policy being to cooperate with and supplement existing transportation companies.

Hertz to Be Chairman

John Hertz, chairman of the board of the Chicago Motor Coach Corp., and John A. Ritchie, now president of that corporation and formerly president of the Fifth Avenue Coach Co., will serve as chairman of the board and president respectively of the Omnibus Corp. The board will inclue Mr. Hertz, Charles A. McCulloch, Mr. Ritchie, Leonard S. Florsheim, W. Rufus Abbott, Otto W. Lehmann, John Borden, John R. Thompson, William Wrigley, Jr., and Edward N. D'Ancona, all present directors of the Chicago Motor Coach Corp., and Grayson M-P. Murphy, Charles H. Sabin, Albert Strauss, Harold E. Foreman, George A. Green, Harvey T. Woodruff, James B. A. Fosburgh, John C. Jay, Emanuel Lascaris and Edmond E. Wise.

It is stated that none of the existing companies to be taken into the combina-

(*Continued on page* 86)

Business in Brief

Written exclusively for AUTOMOTIVE INDUSTRIES *by the Guaranty Trust Co., second largest bank in America.*

NEW YORK, July 2—More favorable weather has brought improvement in crop prospects and retail trade, but the general industrial situation remains essentially unchanged. Commodity prices tended downward last week, while stock quotations were distinctly strong. The extreme ease in money rates persists.

Car loadings in the week ended June 14 numbered 902,710, comparing with 910,707 in the preceding week and 1,008,838 in the corresponding period last year. Total loadings thus far this year are 21,374,652, as against 21,979,049 for the same period in 1923 and 18,291,101 two years ago.

Railroad reports so far available for May indicate general declines from 1923 figures of both gross and net earnings. In some instances, however, remarkable reductions have been effected in operating expenses. Freight cars installed by Class I railroads during the first five months of this year numbered 58,555, compared with 61,809 during the same period last year. Freight cars on order on the first of June were 61,256, as against 107,079 on June 1, 1923.

Production of crude petroleum during the week ended June 21 averaged 1,978,550 barrels a day, comparing with 1,988,200 in the preceding week and 2,135,450 a year ago.

Business failures reported by Bradstreet's for last week numbered 340, compared with 409 in the preceding week and 335 in the corresponding week last year.

Fisher's index number of wholesale commodity prices stood at 142.7 last week, marking a new low point for the year. This figure represents a decline from 143.4, which has been maintained for two weeks.

Discounts by Federal Reserve banks declined $1,200,000 during the week ended June 25. An increase of $3,700,000 in bills secured by Government obligations was more than offset by a loss of $4,900,000 in "other bills discounted."

Hudson Lists Coach at Price of Phaeton

Company Establishes Precedent by Quoting Same Price for Open and Closed Model

DETROIT, July 1—For the first time a closed model has been listed at the same price as its running mate, the open car. This precedent has been established by the Hudson Motor Car Co., which announced that its coach and seven-passenger phaeton will list as $1,500 each.

This statement accompanied the announcement that all models in the Hudson and Essex lines will be equipped with balloon tires. Prices on the Hudson models with the new equipment are reduced in two instances and remain practically unchanged in the other three. On the Essex models prices are increased $25 and $50.

Complete prices on the lines are:

Hudson speedster, $1,400; phaeton, $1,500; coach, $1,500; five-passenger sedan. $2,150; seven-passenger sedan, $2,250.

Essex phaeton, $900; coach, $1,000.

M. A. M. A. Fall Meeting to Be Held in October

NEW YORK, July 2—The fall meeting of the Motor and Accessory Manufacturers Association will be held in Cleveland during the week of Oct. 6, according to announcement from the headquarters of the association. Definite dates will be announced later.

The meeting, which will cover three days, is dated later this year than last, when it was held in Boston in September. Various committees in charge of arrangements are working out details.

Business Men in Peoria Endeavor to Save Avery

PEORIA, ILL., June 30—The Association of Commerce, which has approved the project to buy up the Avery Co., is now conducting a well organized campaign in the city to raise $2,500,000 to finance the deal. Canvassing committees emphasize that this is not a reorganization project—the old Avery Co. is off the map. The present undertaking is the launching of a new concern built upon the Avery materials.

Assets of the old company, listed at $8,956,080, according to a certified report of accountants, would be bought. First goal is to secure $500,000 common stock subscriptions to provide working capital. The sale of $2,000,000 preferred bonds and stocks will finance the purchase through the courts and this money will go direct to creditors of the old firm after court and incidental expenses have been deducted.

It is proposed, too, to bring the Milwaukee plant to this city and consolidate the two units.

New "Standard Six" Produced by Buick

Four-Cylinder Chassis Has Been Dropped but Older "Six" Is to Be Continued

[*Announcement of the Standard Buick was made as this issue was about to go to press, and as it is the Annual Engineering Issue, an early closing of forms was necessary. A complete description of the Standard Buick will be published in* AUTOMOTIVE INDUSTRIES *next week.*—Ed.]

FLINT, MICH., July 2—A new six-cylinder chassis has been added to the Buick line and the four-cylinder chassis has been discontinued. The new six-cylinder engine has 25 per cent less displacement than the older one, which will be continued.

To distinguish the two lines, the older and larger model will in future be known as the Master Six and the newer and smaller one as the Standard Six. Eight body models will be furnished with the Standard Six and fifteen with the Master Six, making 23 car models in all.

The Standard Six engine has 3 by 4½ in. cylinders, giving it a displacement of 191 cu. in., and is mounted on a chassis of 114¾ in. wheelbase. It develops 50 hp. at 2800 r.p.m. As regards acceleration, the smaller car is said practically to duplicate the performance of the Master Six, and a maximum speed of 70 m.p.h. is claimed.

Details of the Standard chassis are very similar to those of the Master chassis (the older Buick Six model) and the bodies for the two lines are also of similar design. The leg room is the same in the smaller as in the larger car, the smaller chassis having been designed to fit the bodies, rather than the bodies to fit the chassis. The four-wheel braking system has been continued without change on the Master Six and is also used on the Standard Six.

H. C. S. Will Add Taxicab to Its Line of Products

INDIANAPOLIS, June 30—The H. C. S. Motor Car Co., through its president, Harry C. Stutz, announces that it will enter at once the taxicab field and build a new design taxicab to be lighter and lower in price than conventional taxicabs of the better sort. Demonstrating models are to be ready in sixty days.

The new type of vehicle will not be allowed to interfere with the production of H. C. S. passenger cars, which will be continued. The taxicabs with the passenger car production are expected to place the plan at capacity operations in a short time.

Though details of the chassis have not yet been announced, it is understood that it will be composed of standardized units with special developments and advancements which have not hitherto been usual in taxicab design or construction.

The H. C. S. plant, while compact and located in the heart of the city, is said to be very well adapted to an expanded production campaign, its facilities being so arranged that a considerable increase in vehicle construction can be brought about without additional plants or floor space.

BOTTLERS WILL SHOW HOW THEY USE TRUCKS

WASHINGTON, July 1—Figures furnished the Government by the American Bottlers' Carbonated Beverage Manufacturers Association estimate that last year's soft drink sales were 8,000,000,000 six and one-half ounce bottles.

One of the exhibits at the forthcoming convention of that association next fall at Louisville will show how the manufacturers handle this volume of goods with an estimated breakage of 0.001 per cent through specially built trucks. The truck exhibit will be one of the 122 of the largest American manufacturers of machinery for the beverage manufacturers' industry.

All-Season Roadster Announced by Gardner

ST. LOUIS, July 3—The Gardner Motor Co., Inc., after extensive experiments in conjunction with a well-known top builder, has announced an All-Season Roadster. This has a winter top in which special attention has been paid to previous objections to this class of top, that is, buckling back curtain, improper fit around the windshield, etc. These defects are claimed to be eliminated in the new model, which is priced at $1,045.

The top is of slat roof construction, supported by strong crossbows. The winter curtains are of steel and wood construction with vertical window glass which slides in padded felt channels. The top and curtains are padded with interlaced hair and covered with rubberized material. The interior is lined with brown khaki. Summer curtains are supplied as standard equipment.

Gillette Makes Progress in Its Reestablishment

EAU CLAIRE, WIS., June 30—As another step in the reorganization of the affairs of the Gillette Tire Co., which has been conducted by a creditors' committee for a year or longer, the Gillette Tire & Rubber Co. has been incorporated under laws of Wisconsin with a capital of 500 common shares without par value. C. E. Blake, E. H. Pett and J. J. Martin appear as incorporators.

The affairs are gradually being worked out on a satisfactory basis. Meanwhile the plant is being operated steadily and no difficulty is experienced in marketing the entire output.

Ajax Motors Formed As Nash Subsidiary

Incorporated as Part of Plan to Operate Mitchell Plant Bought Early in Year

RACINE, WIS., July 1—Plans for operation of the old plant of the Mitchell Motors Co., Inc., at Racine Junction as a subsidiary of the Nash Motor Co. of Kenosha were announced here by Charles W. Nash, president of the Kenosha corporation, in connection with the filing of articles of incorporation at Madison for an organization which is to be known as the Ajax Motors Co.

The old Mitchell factory at Racine Junction was acquired by the Nash interests early in the year and since that time much speculation has been rife as to what use the plant would be put.

Full details as to the purposes of the Ajax Motors Co. are not yet available. It has been unofficially reported that Nash intends to use the plant in the production of a new light car. That it is to play an important industrial role is suggested in the fact that the Ajax organization is to have a capital stock of $3,000,000 consisting of 7 per cent cumulative preferred stock and 30,000 shares of common stock without nominal or par value. Equal voting power will be vested in both classes of stock and it is stated that the entire issue will be subscribed by the Nash organization.

Appearing as incorporators in the application for charter are the names of Charles W. Nash, Walter H. Alford and James T. Wilson, all of Kenosha and identified with the Nash company.

The Mitchell plant has not been occupied since last March when it was vacated by the Mitchell Motor Car Co., following the Nash purchase, which was formed to take over patents, designs, parts and service rights and considerable material of the bankrupt Mitchell Motors Co., Inc.

Most of Maxwell Sales Have Been Closed Cars

DETROIT, June 30—Important increases in closed car business is shown by Maxwell and Chrysler cars in the first four months of 1924. Maxwell closed car business in this period has increased to an average of 54.4 per cent as compared with 24.5 per cent for the same period last year and 37.5 per cent for all of 1923. Chrysler output to date has averaged 47.5 per cent closed.

The higher Maxwell ratio is declared due to the popularity of its club sedan and club coupe models whereas the lower ratio of the Chrysler closed models is said to be due to the popularity of its roadster model. Demand on the Chrysler roadster is declared still in excess of a large production on this particular model.

Citroen Tells Trade of Advanced Prices

Lists Go Up 1000 Francs—Cars to Carry Balloons as Standard Equipment

PARIS, June 25 (*by mail*)—An increase of 1000 francs on all cars, to be retroactive to May 15, is the announcement which André Citroen made to his dealers at the periodical trade congress held in Paris last week. It was also announced that in future all deliveries would be made on balloon tires. Because of the higher cost of balloon over high pressure tires, the net increase in price on Citroen cars really amounts to 750 francs.

The announcement was not unexpected, for Citroen several months ago warned his dealers that orders should only be accepted on the understanding that prices might be increased without warning. Several French firms are refusing to book orders on a fixed price basis, except for immediate delivery. The manufacturers reserve the right to increase prices without notice, but give clients the option of cancelling.

While Citroen is the first in France to announce balloon tires as standard equipment, the proportion of cars up to 12 hp. delivered by big manufacturers on high pressure tires is only about 25 per cent of the whole, and the indications are that several others will soon make balloons standard equipment.

Citroen is now averaging 220 cars a day, while Renault's output stands at 140 a day average. The latter firm, however, producing cars up to 40 hp., has a bigger turnover.

Patent Decision Given to Hall Cylinder Hone

TOLEDO, June 30—Judge Westenhaver of the United States District Court has handed down a decision in the case of the Auto Hone Co. of Buffalo, against the Hall Cylinder Hone Co. of Toledo, holding that the latter does not infringe the Emery patent, controlled by the Auto-Hone company.

The device in question is a portable grinder primarily used in truing-up out-of-round cylinders and is operated with a portable electric drill. In its decision, the court held that the Emery patent is valid but not infringed, and continues, saying:

> Emery is not entitled to claim any and all means of mounting abrading members so as to make them rotable about the axis of the shaft and radially distant therefrom, but merely the means disclosed in his patent or the substantial equivalent thereof. The omission from defendant's device of the control levers and wedge cone, the position of which limits or controls the swinging of the arms and permits the adjustment and readjustment of the radial distance of such arms from the shaft without the substitution therefor of any substantial equivalent, precludes infringement.
>
> Moreover, there is an entire lack of interchangeability between the novel elements of the two devices. Emery would be inoperative without the levers and adjusting cones. Defendant's device would be inoperative with them. Interchangeability of parts is a standard test of infringement, and when not interchangeable, the presumption against infringement is strong.

The Auto Hone Co., admitting that the Hall company has won the first round, declares that it expects to appeal from Judge Westenhaver's decision.

Stewart-Warner to Move Elgin Branch to Chicago

ELGIN, ILL., July 1—It has been decided to dismantle the local branch of the Stewart-Warner Speedometer Co. of Chicago and to consolidate it with the main concern. About seventy-five employees have been engaged at Elgin and they will be given positions in Chicago, if they care to take them.

Three years ago the Van Sicklen company of Elgin sold out to the Stewart-Warner company and since then plans have been slowly materializing for the centralization of all interests of the company in Chicago, the last step to be taken with the transfer of the Elgin branch, effective on July 1.

It is expected that the seven executives who have been in charge of the Elgin branch will also be placed in Chicago by the company.

Net Loss of £327,263 Reported by Wolseley

LONDON, June 25 (*by mail*)—The report of Wolseley Motors, Ltd., a subsidiary of Vickers and one of the foremost half-dozen car makers in England, shows a net loss of £327,263 for the year ended Sept. 30, last. To this is added a debit balance of £108,822 brought forward.

A trading profit of £91,687 is shown, but owing to increased keenness of competition the board has considered it imperative to write-down the inventory figures which took the stock and work-in-progress at cost. A substantial proportion of the expenditure on dies and tools has also been written-down. These provisions, payment of interest on debenture stock and other fixed charges account for the deficit.

Income of Kelly Truck Reported at $190,049

SPRINGFIELD, OHIO, June 30—Reports filed with the Common Pleas Court by Receiver P. A. Lewis show that net income of the Kelly-Springfield Motor Truck Co. from Dec. 16, 1922, to Dec. 31, 1923, totaled $190,049 from a total net sales of $2,046,153.

An inventory and appraisal taken by order of the receiver place the value of the real estate and machinery under mortgage at $571,584; other property not included in mortgage, $393,274, and miscellaneous equipment in branches in other cities, $1,000,228.

Delegation Winds Up Its Highway Studies

Latin Americans Return to Washington After Extensive Tour of Country

WASHINGTON, July 2—Twenty-eight delegates to the Pan-American Highway Congress are here this week winding up their intensive study of highway construction in this country. Under the auspices of the American Highway Educational Bureau and the National Automobile Chamber of Commerce, the delegates spent from June 3 to June 29 in a study of highway conditions in nearly a score of States and made a survey of the automobile and tire manufacturing industries in Michigan, Ohio and other automotive construction centers.

The purpose of the four-day "post-graduation" course, as it were, here this week is to give the delegates a composite picture of how the Federal Government is linking up its highway construction program with the 48 States.

Day's Study Outlined

Each morning the delegates have met in the Colombia room of the Pan-American Building for an outline of the day's study. The first day was spent in the Bureau of Public Roads, where they were shown road construction on a minimized scale, how bridge testing is done, drainage, grade estimates and a multitude of other details incident to highway construction and financing.

The afternoon of the second day was spent in the study of actual road building at the governmental experimental station near here. Today they are being shown through the Department of Commerce and especially the automotive division of that department, where data are secured from all parts of the world relative to the automobile business. Tomorrow the delegates are to be shown through the Bureau of Standards, with its engine testing laboratories and other bureaus.

Many of the delegates will return to their countries the last of this week and with them will take, what is declared to be the most composite picture ever given of any industry in this country. As a result of their 30-day intensive study they have not only been shown the United States Government's method of highway construction, but what it has been to this country and how the automobile has brought wealth to remote sections, possible in no other way except through the medium of good highways and the automobile.

Akron Interested in Visit

AKRON, July 1—The meeting of the Pan-American highway commissioners, who are studying American road building methods, with the leaders in the Akron rubber industry under the auspices

(*Continued on page* 87)

Exports Fell in May; 5 Months' Total High

Cars and Trucks Declined from April—Aggregate, However, This Year Is Above Last

WASHINGTON, July 3—A decline in exports of both passenger cars and trucks made in the United States is noted for May as compared with April, according to figures compiled by the Department of Commerce. May of this year, however, was better than May of last. For the first five months of 1924, exports of passenger cars amounted to 70,149 as compared with 52,254 in the corresponding period of 1923. Truck exports for the same period in 1924 reached 12,481 as against 9849 for the first five months of last year.

May exports of passenger cars aggregated 14,363 compared with 12,500 in May of last year, and contrasted to 15,808 in April of this year, 14,035 in March, 13,329 in February and 12,614 in January.

The 2739 trucks exported in May of this year compares with 2605 in May of last year and with 2764 in April of this year, 2839 in March, 1704 in February and 2845 in January.

The value of this May's exports of passenger cars is $10,581,617 contrasted to $8,534,265 last May, and of trucks, $1,593,833 compared with $1,236,416.

Details of the shipments of automotive products are given in the table published on this page.

Rotterdam Ford Branch Makes Gain in 5 Months

DETROIT, June 27—Sales of the Ford Motor Co. of Holland, located at Rotterdam, for the first five months of the year were 3252 cars and trucks, 72 Fordson tractors and nine Lincoln cars, a substantial increase over the business in the same period of 1923, the company reports.

The Rotterdam organization now controls 76 authorized dealers in Holland, and there are 63 employees at the branch. The branch was established in 1923 to gain a closer unity with the representatives than was possible under the former system of control by the Antwerp, Belgium, Ford factory. The Rotterdam plant stocks cars and parts and sends out roadmen similarly to assembly branches elsewhere. No assembly work, however, is done there.

The record of increased business shown in Holland is declared by the company to indicate how demand in Europe is paralleling the increased business in the United States.

BUFFALO TRUCK BANKRUPT

BUFFALO, June 28—The Buffalo Truck & Tractor Corp. of Clarence yesterday filed a voluntary petition in bankruptcy, listing its total assets at $66,632 and liabilities at $271,232. In the liabilities are secured claims of $58,662 and unsecured claims of $159,646. The greater part of the assets of the corporation are real estate, $32,750, and machinery and tools, $9,000.

Exports, Imports and Reimports of the Automotive Industry for May of Current Year and Total for Eleven Months Ending May 31.

	Month of May				Eleven Months Ending May			
	1923		1924		1923		1924	
EXPORTS								
	No.	Value	No.	Value	No.	Value	No.	Value
Automobiles, including chassis	15,121	$9,795,725	17,105	$12,177,735	104,765	$73,710,783	158,068	$112,725,915
Electric trucks and pasengers cars	16	25,044	.....	.....	271	359,354	92	128,530
Motor trucks and buses, except electric:								
Up to 1 ton	2,175	687,320	1,590	615,572	12,411	4,454,984	16,163	6,620,036
Over 1 and up to 2½ tons	367	411,662	508	649,241	3,096	3,687,656	4,371	5,708,191
Over 2½ tons	63	137,434	64	147,803	684	1,848,110	1,273	3,227,155
Total motor trucks and buses, except electric	2,605	1,236,416	2,739	1,593,833	16,191	9,990,750	25,660	17,086,657
PASSENGER CARS								
Pasenger cars, except electric:								
Value up to $500 inclusive	6.115	2.245,117	5.405	1,903,763	22,818	7,895,488	51,053	18,347,070
Value up to $800	2,269	1,526,966	4,106	2,717,887	34,695	19,223,888	36,195	23,900,648
Value over $800 and up to $2000	3,846	4,030,908	4,505	4,973,766	28,624	30,291,456	42,141	45,171,345
Value over $2000	270	731,274	347	986,201	2,166	5,949,847	2,856	8,004,451
Total passenger cars, except electric	12,500	8,534,265	14,363	10,581,617	88,303	63,360,679	132,245	95,423,514
PARTS, ETC.								
Parts, except engines and tires*	.....	.....	.....	.....	29,316,512	18,618,812	.....	.....
Automobile unit assemblies*	9,351,791	1,350,248	1,624,542	348,580	14,918,175	2,295,316	13,697,099	2,650,219
Accessories and parts*	15,601,479	4,208,377	.....	.....	101,122,740	22,680,594	125,203,670	27,912,939
Automobile service appliances (not elsewhere specified)*	125,845	80,851	747,858	189,864	437,801	250,422	3,825,119	1,560,392
Station and warehouse motor trucks	24	7,116	13	9,090	131	80,187	205	120,050
Trailers	90	55,489	63	26,225	836	339,987	464	176,072
Airplanes	1	300	1	7,500	34	351,030	59	341,836
Parts of airplanes, except engines and tires*	1,277	960	26,737	46,167	428,634	232,451	291,846	155,983
BICYCLES, ETC.								
Bicycles and tricycles	4,137	22,414	574	16,016	22,045	168,038	17,184	198,473
Motorcycles	1,859	445,223	1,673	389,190	17,775	4,186,354	18,838	4,647,803
Parts except tires*	321,953	151,338	299,972	158,441	2,614,087	1,364,798	3,093,353	1,621,545
INTERNAL COMBUSTION ENGINES								
Stationary and portable:								
Diesel and semi-Diesel	359	130,976	32	17,990	920	406,664	1,440	485,413
Other stationary and portable	.....	.....	.....	.....	14,729	1,781,589	.....	.....
Not over 8 H.P.	2,969	256,667	2,245	196,146	11,343	891,050	23,552	2,124,512
Over 8 H.P.	113	72,251	312	171,544	643	377,513	2,625	1,518,747
Automobile Engines	.....	.....	.....	.....	15,619	1,910,857	.....	.....
Motor trucks and buses	1,188	134,932	33	13,278	2,235	263,857	1,121	129,569
Passenger cars	5,566	744,946	1,468	231,437	21,396	2,592,760	24,724	3,714,549
Tractors	611	108,514	122	54,596	698	142,106	1,741	474,796
Aircraft	1	250	22	29,800	67	38,457	170	206,481
Accessories and parts*	616,422	270,619	659,855	311,445	6,292,169	2,675,257	7,799,553	3,394,253
IMPORTS								
Automobiles and chassis (dutiable)	61	73,062	63	88,449	508	801,853	784	806,308
Other vehicles and parts for them (dutiable)	.....	272,831	.....	81,690	.....	1,171,703	.....	1,437,218
REIMPORTS								
Automobiles (free from duty)	84	83,738	33	26,221	3,162	3,834,679	367	545,479

*Pounds.

Men of the Industry and What They Are Doing

Clausen Heads J. I. Case T. M.

Charles Deere Wiman, great-grandson of John Deere, founder of the implement industries in Moline, Ill., which bear his name, will become vice-president of the central plant, Deere & Co., July 1, succeeding L. R. Clausen, who becomes president of the J. I. Case Threshing Machine Co., Racine, Wis.

Mr. Clausen was graduated from the University of Wisconsin in 1897, entered railroad work and rose to positions of prominence in the signal division. He was president of the Railway Signal Association of America in 1907.

He resigned railroad work in 1912 and came to Deere & Co., and after a short period in the local factories went to Ottumwa, Iowa, as plant manager, transferred back in 1917 to take over the work of Col. George W. Mixter, then in war work, and in 1919 became a director and vice-president in charge of operations.

Mr. Wiman was graduated from Yale in 1915. He saw Mexican border service, received pilot license from the Aero Club of America during the war, was injured in a flight but returned overseas in the artillery branch of the service. After demobilization he entered the plant and became general manager of the Union Malleable Co.

Matheson with General Motors

C. W. Matheson, formerly vice-president in charge of sales of Dodge Brothers, has been appointed an assistant to the president of General Motors Corp. No definition of Mr. Matheson's duties was made in the announcement of the appointment by President A. P. Sloan, Jr.

Biechler Named Delco Manager

E. G. Biechler has been appointed general manager of the Delco-Light Co. of Dayton, Ohio, a General Motors subsidiary. Mr. Biechler was sales manager and since February has been acting general manager. In his new position he succeeds R. H. Grant, who recently was appointed vice-president and general sales manager of the Chevrolet Motor Co.

Harrison Appointed General Manager

O. L. Harrison, who since Jan. 1 has been acting general manager, has been made general manager of the Dayton Engineering Laboratories Co. of Dayton. Ohio.

Carpenter Named a Vice-President

Ralph E. Carpenter, heretofore assistant to the president of the Spicer Manufacturing Co., has been elected a vice-president of the company. Mr. Carpenter was formerly sales manager of the Taft Peirce Co. of Woonsocket, R. I., and later assistant to the president of the Aluminum Castings Co. and manager of its experimental laboratories.

ASSOCIATION DROPS FOREIGN CAR SHOW

NEW YORK, June 30—There will not be two foreign car exhibitions in New York this fall as was the case last year, the Foreign Automotive Association, which promoted the affair at the Astor, having decided to give up the show idea. The association, however, will not disband, its members having other objects in common which makes such an organization valuable.

It is possible that most of the members of the Foreign Automotive Association also will join the foreign section of the Automobile Merchants Association of New York, which would make them eligible to participate in the closed car show of the New York dealers to be held in the Grand Central Palace.

Wills Returns from Europe

C. Harold Wills, president of the Wills Ste. Claire Co., has returned from a trip to Europe. During his trip he investigated the possibilities of the European market for Wills Ste. Claire cars. Mr. Wills declared that automotive conditions are much better in Europe than in the United States at the present time.

Bosshart Sails for South America

H. J. Bosshart has sailed from New York for South America to make an extensive trip in the interests of North East Service, Inc., and the North East Electric Co. His first point of call is Lima, Peru, from which city he goes to Valparaiso and Santiago, Chile, thence across the Andes to Buenos Aires, Montevideo, and eventually to Brazil. After completing the South American itinerary Mr. Bosshart will visit all important cities in South Africa, Australia and New Zealand. His main purpose is the extension of the North East service organization in those places where North East equipped cars are in use.

Herreshoff with Rushmore

A. G. Herreshoff has resigned as mechanical engineer after a connection of nearly three years, to become associated with the Rushmore Laboratory, Plainfield, N. J., for the development of the Rushmore Cooling System and other devices. Prior to his present connection Mr. Herreshoff was identified for many years with Mack Trucks as engineer of new design and was formally associated with his father, N. G. Herreshoff, of international yacht fame.

Cadillac Appoints Van Arsdale

Samuel Owens Van Arsdale has been appointed divisional comptroller of the Cadillac Motor Car Co. to fill the vacancy occasioned by the death of Herbert J. Lount. Prior to his recent appointment, Mr. Van Arsdale was stationed at Indianapolis, where he was supervising the financial interests of the General Motors Corp. At one time he served as traveling auditor of the du Pont Co. and as assistant auditor of General Motors.

Woodruff to Attend Convention

J. Fred Woodruff, general manager of the Campbell-Ewald Co., left Detroit this week with Mrs. Woodruff to attend the international advertising convention in London. After the convention Mr. Woodruff will spend some time studying business conditions in Great Britain and on the Continent.

Lester Leland Resigns

Lester Leland has resigned all of his connections with the United States Rubber Co. Mr. Leland has been vice-president or vice-chairman and member of the executive committee of the company for the last 25 years.

Belgium Honors Bakeland

Dr. Leo Hendrik Baekland, president of the Baekland Corp., president of the American Chemical Society and professor of chemical engineering in Columbia University, has been made a Commander of the Order of Leopold by King Albert of Belgium.

Spillman Opens Offices

E. O. Spillman, formerly chief engineer of the Herschell-Spillman Co., has opened an office as consulting engineer and has arranged a shop for building experimental engines and testing at North Tonawanda, N. Y.

Krug Manages Jamestown Malleable

W. L. Krug, formerly manager of the malleable department of the Gould Coupler Works, has become general manager of the Jamestown Malleable Products Co., Jamestown, N. Y.

Holmes Succeeds Miller

B. Miller, for the last ten years treasurer of the Miller Wagon Co. of Calmar, Iowa, has resigned and moved to California. He is succeeded by A. Holmes.

FRANKLIN RESUMES ASSEMBLING

SYRACUSE, N. Y., June 30—The Franklin Automobile Co., following the completion of the inventory, for which production was temporarily halted, has resumed assembly work. The company states that retail deliveries to dealers are running at the rate of better than 800 a month.

Fords Build Landing Field for Airplanes

They Do It as Incentive to Airship Construction Now Going on in Detroit

DETROIT, July 1—A commercial landing field for Detroit's commercial aviation activities is being built and furnished at Dearborn by Henry and Edsel Ford as an incentive to those working on metal airplane and airship construction in Detroit.

The field, which is almost three-quarters of a mile square, is located at Dearborn on Oakwood Boulevard, adjoining the new Ford administration building, and on it is being built, as well, a factory for the Stout Metal Airplane Co. of Detroit, builder of the air pullman "Maiden Detroit," which has been flying in passenger work about this city for the past two months, and the Aircraft Development Corp., another Detroit firm, working on all-metal dirigibles of a super-Zeppelin type.

Is Patriotic Move

This field has been furnished for these two companies as a civic development and as a national patriotic move, "there being no intention on the part of the Ford Motor Co. to go into the airplane business other than to watch its development," was the announcement given out this morning by Edsel Ford.

"We have followed the aviation development work that has been carried on by both the Stout Airplane and Upson Airship groups for some time and believe that the results which they are obtaining justify every encouragement that Detroit can give toward making this the center of metal aircraft production."

It is planned to make this an ideal airport. It has the advantage of being only 25 minutes from the postoffice by motor car, which will have a distinct bearing on air mail activities coming into and going out of Detroit. It is near the Michigan Central Railroad, close to proposed street car and bus lines and an ideal location for commercial flying in and out of Detroit.

This is not meant to take the place of the establishment of a municipal landing field, but to be a strictly commercial development and the operation basis of airlines for aviation companies coming into and out of Detroit.

Site Being Prepared

Twenty-five tractors are now at work in the area, levelling it off and preparing it for actual flying work within the next 30 days, while contracts have been signed for the new factory buildings which will house the Aircraft Development and Stout Metal airplane groups. Also the operating companies later to be formed will center their activities at the field.

The Stout directorate includes: Edsel B. Ford, Sidney D. Waldon, Charles B. Bohn, W. O. Spriggs, Charles T. Bush, H. H. Emmons, William B. Mayo, Fred Fisher, Harry R. Graham, George M. Holley, C. F. Kettering, R. A. Stranahan, Fred W. Warner, Arthur T. Waterfall, William B. Stout. R. A. Stranahan is president of the Stout company, and William B. Stout is general manager.

U. S. CHAMBER ADOPTS COMMITTEE'S REPORT

WASHINGTON, June 30—By a vote of 23,214 to 4191, the recommendations of the Special Committee on Transportation of the United States Chamber of Commerce were adopted by a referendum vote as announced by that organization.

Of the 14 recommendations, four concern the greater use and utility of motor vehicle transportation as one of the paramount means of solving the country's transportation problems.

Studebaker Operations Resumed at South Bend

SOUTH BEND, IND., July 1—South Bend plants of the Studebaker Corp. have resumed operations after more than three weeks' shut down. At present 3000 men are at work, and the employment schedule calls for an additional 1200 to be added during the week of July 7. The period July 14 to Aug. 7 will see 2000 more employed. These additions will constitute approximately 55 per cent of the number employed at peak of production.

Men will be added throughout the summer months until the maximum of production will be reached about Oct. 1. The immediate and certain clearing of the campaign issues, which are cited as the cause of the present depression, is expected to bring about a decidedly optimistic attitude in automotive buying and producing circles.

Employees returning to work will be equally divided among all departments, with the exception of the closed body plant. Total men at work by Aug. 1 is expected to be about 6200.

Marcellus P. Cromling Dies from Heart Attack

TOLEDO, June 30—Marcellus P. Cromling, director of purchases of the Willys-Overland Co., died here Friday from a heart attack which came upon him two hours before death.

Mr. Cromling had been with Willys-Overland about four years, having come to Toledo from the Buick plant in Flint, where he occupied a similar position. Previous to that time he had served with the United States Steel Corp. for nineteen years.

He had just recovered from a severe illness and it is believed his heart trouble was induced from that previous trouble.

Goodyear and Miller Bring Out New Tires

Product of Former Is Made from "Supertwist" Cord—Latter's Is for Use on Buses

AKRON, July 3—Two new tires have been announced by the Goodyear Tire and Rubber Co. and the Miller Rubber Co. The two new announcements constituted the first innovations in the tire field for the last six months.

The Goodyear Tire and Rubber Co. announced a new balloon cord tire made from "Supertwist" cord material, which, according to the announcements by the company, will practically double the life of the tire. The company in its statement emphasizes the fact that the fabric from which the new tires are made is the product of its own cotton plantations in the southwest.

The company, however, refused to make any statement as to details of production or the makers of the fabric. The price of the new tires is said to be on a par with previous prices on balloon tires. The company stated that no cut had been made in the price of balloons as was intimated in some quarters.

The Miller announcement covered a new bus tire, fabricated for a combination of loads and high speeds. The company in its announcement pointed out that bus interests have demanded a different kind of a tire for buses than is used for trucks because the buses operate at a higher speed but with the same loads in many instances.

Through the use of cord fabric, which is said to be at least 30 per cent stronger than that used in previous tires, the carcass of the tire, despite fewer layers of fabric, is stronger in the new tires than in the regulation cords.

The company has not as yet decided upon a name for the new product but stated that the price is the same as that of other tires of the same size.

Rainbow Tire Progresses with Its New Tube Plant

COLUMBUS, OHIO, July 3—The Rainbow Tire & Rubber Co., which has general offices in Columbus, is making rapid progress in preparing its large tube making plant at Delaware, Ohio, for operation. The company, capitalized at $1,000,000, will have approximately $600,000 invested in the plant, equipment and material by Aug. 1, when it is believed active operation will start.

The buildings, comprising a main factory and power plant, have been completed and a large part of the tube making machinery has been installed. The power plant, with boilers of 1200 hp. capacity, is practically finished. Charles E. Ross is president and general manager of the company.

The initial capacity of the plant will be 2000 tubes daily.

SURPLUS STOCKS REDUCED BY DEALERS

Detroit

DETROIT, July 1—Dealer stocks in the Detroit district are being rapidly lowered under the impetus of special sales concessions which have been authorized from factories generally, and while these will be brought to a low point, the business of the month will not be as high as in some of the earlier months of the year.

In the case of two companies which are introducing models shortly, dealer stocks have been entirely cleared out in this city, though the State condition is somewhat less favorable. On these two lines of cars it has been practically impossible to get deliveries during the present week because dealers were closed out of the old models and the new ones are not ready for delivery pending official announcements.

Taking the city generally, dealers are in good condition as regards stocks, but as these have been moved largely on a sacrifice basis, the dealers are not looking for continuance of heavy deliveries and are seeking to reduce factory pressure. Throughout the State, however, business is considerably slower as the industrial situation has been poor for several months and farmers are not taking cars in quantity.

The industrial slowing down of the city has reduced buying to much lower levels than normally would have been the case. Dealers report that as long as factories were working business was holding up strongly. With the reduction of factory operations, however, business fell off and numerous instances are reported of cancellations after deposits had been made. Used cars have been moving better with improved weather conditions, but there are still large quantities in the city.

Indianapolis

INDIANAPOLIS, July 1—Indiana car dealers enter the second half of 1924 with smaller new car stocks than at any time this year. In many cases dealers and distributors are rather clean of new stocks and are fairly ready for the new models. June ran from 15 to 20 per cent below the top May and April figures, but June in Indiana is always a slower sales month than April or May.

Final registration figures of new cars for the entire State will not be available for two weeks, but advance figures for this city and locality show that the fall off in sales was not as great as some expected. State business as exampled by the fastest selling line will be off less than 15 per cent and may not be worse than 12 per cent. The rural parts are reported in good condition and a relatively better July than June is looked for.

Used cars are still as abundant as in former months in many quarters in spite of forcing methods tried in recent weeks.

BETTER WEATHER AIDS SALES IN BIRMINGHAM

BIRMINGHAM, ALA., July 1—Dealers report that their stocks of new cars are moving fairly well, but the large majority of them state that they will still have some stock on hand in 30 days when the new cars come in, unless some miracle moves them faster than they have been moving in the past two months.

Summer weather has caused an increase in the number of sales of new cars though the dealers have not yet caught up with this time last year.

Used cars felt a decided slump during June. Dealers have been refusing trades in which the used cars consumed the profits. They are therefore not so overstocked as they were earlier in the season.

Salt Lake City

SALT LAKE CITY, July 1—The coming of real summer weather, which was later here this year than usual, did not stimulate the demand for cars. Business, taking the trade as a whole, is not so good right now as it was two or three weeks ago.

One leader in the industry said business would be fine if everything on the street below $200 in value could be destroyed. He declared there was too much junk on wheels right now. People were reconditioning cars that properly belonged on the scrap heap.

The used car situation is not satisfactory. There have been too many tradeins which has had the effect of flooding the market for these cars. A conservative estimate of the used cars on hand places the number at 850. There are, of course, individual firms that are in good shape in respect to used cars, but taking the city as a whole the situation is not what dealers would like it to be.

While a number of firms report their stocks in shape to permit of the purchase of new models, the trade, as a whole, does not agree.

There are a few men in the business who have been doing exceptionally well and who describe conditions as most unsatisfactory right now.

A few weeks ago it was feared that Utah and the Salt Lake territory generally would suffer a serious crop setback. This hurt business, but the outlook is much brighter now. It is estimated today that the crops will be only a little below normal.

In spite of the crop situation the industrial outlook in Utah is good. The new steel plant in Utah County is in actual operation.

Philadelphia

PHILADELPHIA, July 1—Although rainy weather prevailed extensively during June, dealers here made such strenous efforts to move their stocks of new cars on the few pleasant days that they actually succeeded in passing the volume of May sales appreciably and reduced materially the big surplus on hand in storage warehouses.

There is now much better feeling throughout the local trade and undoubtedly many of the local dealers will be ready to take on new models within the next thirty to sixty days.

Although "summer weather" can hardly be said to have produced a volume of sales at all beyond normal, the general improvement in selling conditions is marked, especially when comparing the situation with that in April and May.

A few of the dealers moved their stock by well advertised reduction sales, the price cut ranging from 10 to 33⅓ per cent. The results were regarded as satisfactory, because there were included in such sales a considerable volume of "slow movers," such as town cars of medium or low price, some of this type having had little demand.

There was a scattering of used cars in such reduction sales, but in the main the movement of used cars continues slow and some dealers believe that sweeping reductions may be necessary, if the stock is to be greatly diminished.

Cincinnati

CINCINNATI, July 1—Some improvement is noted in the sales of automobiles in Cincinnati during the past month due to more favorable weather. On the other hand, industries in Cincinnati have been operating on reduced schedules owing to the industrial slump and, consequently, this has been reflected to some extent in the sales of cars. Although automobile sales during the last few months have been below expectations, certain of the higher priced makes have shown a better demand proportionately than the popular-priced cars.

Dealers are moving their stocks better at present than at any previous time this year. There are several large distributors that have been doing a big volume of business and they will be in good shape to receive the new models during the next few months.

The majority of the dealers, however, have not been doing as large a volume of business in June as during the same period in 1923. They have been having fairly steady sales throughout the month and will be in physical condition to handle the new models when they come in.

Used cars are moving in good volume, but are still bringing extremely low prices.

NEW MODELS AFFECTING RETAIL SALES

Los Angeles

LOS ANGELES, July 1—More activity has been shown in retail buying of automotive equipment in the last 10 days than for two months. The demand for all makes of passenger cars does not equal what it was this time last year but with a few lines it is leading. Some of the new lines are doing remarkably well while a few of the older ones are not making as good a showing. Dealers feel encouraged by the trend of events.

Financial conditions are such that loans on the purchase of automobiles can be obtained easily enough if the buyers are willing to accept the terms of interest, which are quite high.

Gasoline and tire dealers assert there is a reduction in the use of cars as evidenced by the slackening in their sales. Undoubtedly the arrival of new models will complicate the situation for some dealers. There still are new 1923 models unsold in the hands of dealers.

One dealer who has received 1925 models has advertised stock of 1924 new cars on hand for sale at a reduction of $200.

Used car business is showing decided improvement and many dealers are advertising they are in the buying market, some stating they are prepared to accept old cars in trade on new ones at no sacrifice in value.

The demand for commercial cars also shows improvement. In some rural sections the market for all motor vehicles will be dead throughout the summer because of crop failures.

Kansas City

KANSAS CITY, MO., July 1—June has proved to motor car dealers that the public was waiting for summer weather to buy cars. Several dealers, especially in higher priced lines, report that June showed a very satisfactory volume, far ahead of May. In general, however, sales are below normal.

Perhaps the most striking feature is the report that business owners are not buying the lower priced cars in usual volume, either for salesmen or for their own use. Salesmen who might have been expected to buy for their traveling are getting by with their old cars.

The large proportion of time transactions in the lower priced lines reflects, it is said, the large percentage of wage earners who are buying—possibly indicating merely that the wage earners are continuing their purchases in usual volume, while other prospects are holding back.

The used car situation is much easier than two months ago, many dealers in higher and lower priced lines having stocks in satisfactory condition, just enough to do business on nicely.

The prospect of new models in some lines has weakened used car prices in such lines, the decline having been anticipated by dealers in allowances. Cars of these lines are selling well, but at lower prices. This weakening is said to indicate that local dealers in some lines which will show changes have substantial stocks of new cars on hand. In general, it may be said that dealers in such lines have pretty well cleared the decks, though it has meant very hard work. It is known that some stocks considered very heavy three months ago are now reduced to proportions which can be easily handled.

Prospects are exceedingly good for sales in July and fall, especially in the wheat country, where the new crop, a large one, is now being harvested. In the Tenth Federal Reserve district the winter wheat crop looks like 60,000,000 bushels more than the amount harvested last year, and the price looks like a dollar a bushel.

NEW MODELS EXPECTED TO STIMULATE SALES

LOUISVILLE, KY., July 1—Automobile business in Louisville has not improved. Sales during June fell off considerably as compared with the preceding month and that of June of last year.

This is the report of conditions by the great majority of Louisville dealers. Less than 10 per cent of the dealers report an active selling month. The advent of 1925 models in several lines, together with other changes, are expected to stimulate the market considerably during July.

Used car stocks on hand are in a reasonably reduced condition. Trading continues to be conservative.

Buffalo

BUFFALO, July 1—Automobile dealers here are experiencing the customary seasonal slump in business. It has come a little earlier than usual.

Some dealers are inclined to attribute the present quiet to the fact that this is a presidential year. Others say politics has nothing to do with the let-down in buying.

Business in June, it is estimated, was one-third less than in the corresponding month of last year. For the first five months of the year business was as good if not better than during the same months in 1923.

Many of the dealers feel that in September business will be good and that there will be nothing to complain about through the rest of the fall.

Used cars have felt the present slump.

St. Louis

ST. LOUIS, MO., July 1—Dealers are prepared and waiting anxiously for the new automobile models to be put on the market next month in the hope that it will give impetus to sales. Things have not been any too bright here during the past month.

Sales have fallen because of the desire on the part of many buyers "to wait until the new models come out before buying." Some firms say they are doing a nice business, but all are emphatic in the statement that they are not doing what they should be doing at this season of the year.

All dealers attribute this condition to the practice of putting new models on the market in the middle of what should be the heavy buying season. Two large dealer establishments went into bankruptcy during the month.

The used car situation varies. Some dealers are cleaned up nicely on used cars, others are overstocked. Right now all are busy making concessions in order to move their stocks to pave the way for the expected increase in sales and the consequent addition to the number of used cars they will have to carry.

Des Moines

DES MOINES, IOWA, July 1—Although May sales in Iowa came within 500 cars of last year's record for the same month, dealers and distributors claim that the automobile business was in a state of stagnation during June. Although no authentic registration figures are available for June, it is doubtful if 10,000 new cars were sold during the month.

Both dealers and distributors are overstocked on new cars. The trend toward higher prices has not proved a stimulus to business. In fact, the price advance in some lines has increased sales resistance. With new car inventories at such a high point, introduction of new models within the next thirty days would but add confusion and cause the retailer to suffer financial loss.

Dealers would be better satisfied if the manufacturer did not introduce the new models for at least 60 days, thus providing time to reduce new car stocks.

Used cars are moving slowly, although better weather has helped this phase of the business. Although used car stocks are not as great as earlier in the year, there are still too many used cars in the hands of dealers.

The financial condition of both dealers and distributors is critical. It is safe to assume that a large percentage of the new car dealers of the State would be glad to retire from the business could they do so at this time without suffering severe financial loss.

(*Conditions in Other Cities on page* 86)

SALES CONDITIONS

Atlanta

ATLANTA, GA., July 1—The automotive industry in the Southeast seems to have almost fully recovered from the recent period of depression, with higher priced cars in considerably greater demand than was the case a month ago, and some improvement in the volume of business also noted by low priced and medium priced cars.

Sales appear to be particularly satisfactory in the smaller towns and communities, especially in low priced and medium priced cars.

This is true principally of Ford dealers, who are enjoying a decidedly good business, with the first half of the year one of the best periods in the Southeast in the history of the Ford business in this district.

The summer outlook gives every promise of being normal for all priced cars, dealers looking for July business to hold up on a satisfactory scale. Regarding the district as a whole, the volume of business at present is about on a par with that of last year at this time, save Fords, which are larger. Used car demand has improved over the same period in 1923.

Seattle

SEATTLE, July 1—With June better than May and an average of 15 per cent ahead of June of 1923, dealers in standard makes of cars are anticipating and have planned for a summer's business based on steady, conservative buying, with purchases outside of the city proper not holding up as well as the strictly urban sales. There has been a substantial betterment in the turnover of used cars compared with a year ago, and the first six months find sales better than the same period of a year ago.

There was very favorable weather as early as February and some of the usual summer purchases were made in earlier spring months. Farming sections are buying very cautiously and there are a considerable number of sales prospects among those who look forward to the coming out of new models in July and August.

Bus Merger Headed by Hertz Interests

(*Continued from page* 78)

tion has a dollar of bonds outstanding or any debt other than current accounts and contract obligations for new equipment under purchase. Nor does the unification of control and management create a debt, it is claimed.

A balance sheet for the combined companies, assuming deposit of all securities dealt with as of Dec. 31, 1923, adjusted to give effect to the financing provided for in the plan shows current assets, exclusive of inventories, amounting to $5,098,085, of which $4,905,785 is either cash or United States Federal or municipal securities, and current liabilities of only $1,582,122.

Fixed assets, including real estate, buildings, vehicles, shops, etc., aggregate $7,474,005. The franchise rights and organization and development expenses figure to the amount of $514,848. Inventories in the way of materials, supplies and construction are valued at $1,061,791. The balance sheet shows total assets of $15,297,499 and liabilities other than stock totaling $4,274,834, giving an excess of assets over liabilities ahead of stock, of $11,022,655.

The plan as announced by the banking interests provides that the new company shall have an authorized issue of cumulative preferred stock of 250,000 shares, par value $100 each, of which 106,378 shares are to be presently issued; and 1,500,000 shares of authorized common stock, without par value, of which 622,195 shares are to be presently issued. The number of shares to be presently issued is based on the assumption that all of the outstanding stock of the New York Transportation Co. and voting trust certificates for stock of the Fifth Avenue Bus Securities Corp. will participate in the plan.

The Omnibus Corp. common stock will be subject to a voting trust of which Messrs. Hertz, D'Ancona, Foreman, McCulloch, Murphy, Sabin and Strauss are to be the trustees.

Continuing its explanation of the financial plan, the bankers say:

> The preferred stock to be issued on consummation of the plan will be known as Series A, will carry dividends at the rate of 8 per cent cumulative from July 1, 1924, and will be redeemable on any dividend payment date at 115 per cent of par value, plus all dividends accrued or in arrears; it will also be convertible into common stock at the rate of three shares of common for each share of preferred. No mortgage can be placed on the company's property nor can any prior issue of preferred stock be created without the consent of two thirds of the outstanding preferred stock. For convenience of making exchanges subshares of the preferred stock will be issued with a par value of $10 each, carrying proportionately the same rights as the preferred shares.

Dunlop Makes 24-Hour Test of Balloon Tires

LONDON, June 25 (*by mail*)—Although the official report with details is not yet available, Sir Eric Geddes announced at the meeting of Dunlop stockholders today that on June 2 and 3 a set of Dunlop wired-on balloon tires on "well-base" rims was submitted to a 24-hour speed test on Brooklands track under the observation of the Royal Automobile Club.

The tires, Sir Eric said, ran throughout the 24 hours on a six-cyinder A. C. car without being touched, and were so little worn that they were capable of repeating the performance. In due course, no doubt, the R. A. C. will issue the report, but until then no information as to mileage covered, tread wear and other particulars of the test are allowed to issue.

FINANCIAL NOTES

General Motors Corp. has notified its common shareholders that on and after Sept. 15, 1924, it will be ready to exchange the present common shares for the new common stock on a basis of four old shares for one of the new, in accordance with the recapitalization plan authorized by the stockholders on June 16.

Rickenbacker Motor Co. has announced another quarterly dividend of 2 per cent payable July 15 to stock of record June 30. This is the seventh dividend paid from earnings by the Rickenbacker company.

Chicago Pneumatic Tool Co. has declared its regular quarterly dividend of 1¼ per cent on its capital stock, payable July 25 to stock of record July 15.

General Tire & Rubber Co. has declared its regular quarterly dividend of 1¾ per cent on the preferred, payable July 1 to holders of record June 20.

Continental Motors Corp. has declared the regular quarterly dividend on the basis of 80 cents annually. It is payable July 30 to stockholders as of July 19.

Hood Rubber Co. has declared the regular quarterly dividend of 1¾ per cent on the preferred stock, payable Aug. 1 to stock of record July 19.

C. G. Spring & Bumper Co. directors have declared a dividend of 5 cents a share payable Aug. 15 to holders of common stock of record Aug. 7.

Nordyke & Marmon Co., it is announced, paid $250,000 of its gold note indebtedness this week.

Milwaukee Buys Trailers Acquired on Rental Basis

MILWAUKEE, June 30—The city of Milwaukee has completed the purchase of 200 Highway trailers from the Highway Trailer Co., Edgarton, Wis., for use in collecting garbage, ashes, waste, etc. The original lot of trailers was placed in service about a year and a half ago on a lease or rental basis of $10 a day, the rental applying on the purchase price. More were added from time to time.

After the city paid the sum of $232,000 in rentals, it was decided to complete the payments to take advantage of a 2 per cent cash discount offered by the Highway company, and $103,000 was paid in a lump sum. The cost of the trailers, therefore, is $335,000, or $1,675 each on the average.

The commissioner of public works already has announced that his budget for 1925 was reduced $500,000, both because there will be no further capital investment in trailer equipment for the present, and owing to savings effected by the new method of collecting and transporting garbage, ashes, etc. During the past winter a huge saving was made in removing snow from city streets.

The trailers ordinarily are operated in trains of three to five, hauled by Sterling tractor-type motor trucks, made by the Sterling Motor Truck Co. of Milwaukee. Other large municipalities are investigating the trailer idea, and Minneapolis is already installing a system similar to that in effect in Milwaukee.

"Coincidental" Lock Gets No Special Rate

Or, at Least, Underwriters Agree to Give Year's Notice Before Allowing It

NEW YORK, June 30—General Manager Alfred Reeves of the National Automobile Chamber of Commerce has notified members of that association that the National Automobile Underwriters Conference has agreed to give the industry one year's notice before granting any preferential credit on cars fitted with coincidental anti-theft locks which operate automatically when the ignition is shut off.

The industry through its Insurance Committee, of which W. E. Metzer is chairman, has been opposed to the granting of a superior theft rate discount on coincidental locks until further investigation. This type of lock is comparatively new and meets with the approval of the underwriters, who feel that it will make owners more careful if the lock operates when the ignition is shut off, compelling the owner to resort to his key before he can restart his engine.

Car manufacturers point out that such a lock will not permit of an engine idling in cold weather and with the lock operative at the same time, thus robbing the owner of the protection of a lock, while it also is pointed out that if a car so equipped stalled on a railroad track it would be necessary for the driver to use a key to restart his engine, thus losing time that might result in an accident.

As the matter now stands, the underwriters have approved several of this type of lock, but because of the feeling in the automobile industry they will not offer special discounts at the present time.

The underwriters also have agreed to discuss with the Metzger committee early next month the proposal of the insurance people to secretly mark the change number on locking devices as a theft preventive. It is felt that this would work a hardship on an owner who has lost a key and does not know the change number of his lock.

Delegation Winds Up Its Highway Studies

(*Continued from page* 80)

of the Chamber of Commerce, besides forming new friendships, has resulted in a new study of the export possibilities of Pan-America and the discovery that the Pan-American countries have become more important to the rubber industry, and especially the tire industry, than all of Europe.

W. O. Rutherford was chairman of the special committee which conducted the delegation through the city and through some of the rubber plants as well as the luncheon at which they were entertained. On the committee with him were F. A. Seiberling, president of the Seiberling Rubber Co.; H. S. Firestone, president of the Firestone Tire & Rubber Co.; George M. Stadelman, president of the Goodyear Tire & Rubber Co., and W. F. Pfeiffer, secretary and treasurer of the Miller Rubber Co.

All of the larger and smaller rubber companies were represented at the luncheon at which various members from the Pan-American and Akron delegations discussed the future development of Pan-American countries.

INDUSTRIAL NOTES

Walker Manufacturing Co., Racine, Wis., specializing in the manufacture of lifting jacks and similar automotive equipment, is erecting a two-story extension to its plant, to house its administrative departments. When this is completed a large area on the ground floor of the plant, now used for offices, will be released to the manufacturing departments, and a considerable increase in the output of jacks will be effected.

St. Anthony Hill Auto Works, Inc., St. Paul, maker of tops and bodies, has been reorganized with A. J. La Mountain, president; and W. J. Shoeneman, secretary and treasurer.

Team and Truck Owners Select New Officials

DENVER, June 30—More than 200 attended the twenty-second annual convention of the National Team and Truck Owners Association, the following officers being elected:

President, W. C. Wheelock, Cleveland; vice-president, E. A. H. Baker, Denver; second vice-president, William T. Grund, St. Louis; secretary, Frank F. Tirre, St. Louis; treasurer, William J. McDevitt, Cincinnati.

F. C. Bartel, Denver; Joseph Glynn, Buffalo; L. A. Sted, Cleveland; W. S. Hamilton, San Francisco, and James C. Snyder, Buffalo, were elected to fill vacancies on the board of directors.

Ground for Unit Broken by Belle City Malleable

RACINE, WIS., June 30—The Belle City Malleable Iron Co. of Racine, Wis., one of the largest makers of malleable for the automobile industries, has decided to prosecute with vigor its $800,000 plant replacement and enlargement program, covering five years, of which two years' work has been completed.

Ground has been broken for the second unit of the foundry, the first of which was finished about a year ago, with a new annealing shop, coreroom, etc. Plans have also been completed and work started on a material storage building, 80 x 133 ft.

FORD BUILDING AT NORFOLK

NORFOLK, VA., July 3—Construction has been started on the assembly plant of the Ford Motor Co. here. When completed it is said the plant will represent an investment of more than $1,000,000.

METAL MARKETS

With order books in as bare a condition as those of the steel producers are, the Fourth of July interruption of operations will be generally welcomed. A number of the mills have practically cleaned up all old orders, and now are dependent for nourishment upon what orders trickle in and, in some cases, a modest amount of output is being stocked. What frame of mind the steel industry is in is best illustrated by an incident that came under the writer's observation the other day. The sales manager of a large producer, having nothing more important to do, was looking over the manifests of European steamship cargoes arrived at New York, when his eyes alighted upon the importation of more than 600 boxes of tin plate from Wales by a New York lamp manufacturer.

"That just goes to show you," said the sales manager by way of comment on the item, "American tin plate is so much superior to the Welsh article that in the Far East the Chinese and other buyers are willing to pay a premium for American tin plate over the Welsh product, but right here at home when the steel market needs a friend more than ever, they will buy imported stuff." In all probability the tin plate shipment to which the sales manager referred was made up of special sizes and gages. No one thinks of importing the ordinary run of tin plate today, but the very fact that this small shipment caused this sales manager to see red, shows how the steel industry feels about the present state of affairs. Not that there is a lack of hopefulness, but it is largely a case of hope deferred.

September is generally expected to bring a revival in the demand. Sheet bar producers have let it be understood that they would be more than pleased if non-intergrated sheet rollers furnished specifications at this time, but the latter are not responding. Consumers of semi-finished products are very well aware of the fact that the steel mills have never been hungrier, for orders and that orders placed now would elicit expressions of gratitude such as have never been accorded buyers before, but they will not bring out lower prices. Concessions have about reached the limit producers are willing to go. This, of course, is due to the insurmountable barrier of wage scales, out of all gear considering the lack of demand. Producers are afraid to tackle the problem of wage readjustments in keeping with the state of the market. They fear labor difficulties no more than they fear unsettlement of market prices.

Pig Iron.—It is remarkable that cheap as pig iron is it has no friends among the speculative element. Buying is all by consumers.

Aluminum.—The world aluminum situation is peculiar. A recent shipment of 2000 bundles of aluminum ingots to Italy shows this. Italy has much nearer sources of supply than the United States, but the jockeying for world control according to agreement among the powers that be, is and has been responsible for many such anomalies in the past. The German Government is being importuned to rescind the order which prohibits the importation of ingots which are very scarce there. The local situation is devoid of fresh developments with the market extremely quiet.

Copper.—With copper selling at the lowest price since the post-armistice slump, brass mills and other consumers are beginning to take more interest in offerings.

Calendar

SHOWS

Nov. 9-15—New York, Annual Automobile Salon, Commodore Hotel.

Jan. 3-10—New York, National Automobile Show, under the auspices of the National Automobile Chamber of Commerce, Bronx Armory.

Jan. 24-31—Chicago, National Automobile Show, under the auspices of the National Automobile Chamber of Commerce, Coliseum and First Regiment Armory.

Jan. 25-31—Chicago, Annual Automobile Salon.

FOREIGN SHOWS

July 1-15—Dunkirk, France, Northern European Fair. Headquarters, No. 2 Rue Gaspard Malo, Dunkirk.

Aug. 3-6—Dantzig, Second International Dantzig Fair, automobiles and allied equipment.

Aug. 23-Sept. 2—Bratislava, Slovakia, International Danube Fair.

Aug. 23-Sept. 6—Toronto, Ont., National Automobile Show in conjunction with the Canadian National Exhibition under the sanction of the Canadian Automotive Equipment Association and the Automotive Industries of Canada.

September—Vienna, Austria, Vienna International Fair.

Sept. 21-28—Prague, Czecho-Slovakia, Prague Autumn Fair.

Oct. 2-12—Paris, passenger cars, motor cycles, bicycles and accessories, Grand Palais.

Oct. 17-25—London, Annual Passenger Car Show, Olympia.

Oct. 22-31—Paris, motor trucks, stationary engines, garage tools and machine tools, Grand Palais.

Dec. 1-13—Montevideo, Uruguay—Second Annual Motor Show, under the auspices of the Centro Automovilista del Uruguay, held in buildings of the Asociacion Rural del Uruguay.

RACES

Aug. 3—Lyons, France, European Grand Prix.

Sept. 1—Altoona.

Sept. 1—Syracuse.

Sept. 7—Monza Track, near Milan, Italy, Italian Grand Prix.

Oct. 2-4—Dayton, Ohio, Fifth Airplane Race for the Pulitzer Trophy.

Oct. 4—Fresno.

Oct. 19—Kansas City.

Nov. 24—Los Angeles.

CONVENTIONS

Sept. 8-11—White Sulphur Springs, W. Va., Annual Meeting of the Automotive Electric Association, Greenbrier Hotel.

Sept. 19-20—Niagara Falls, N. Y., National Battery Manufacturers Association.

Sept. 22-26—Boston, Sixth Convention and International Steel Exposition of the American Society for Steel Treating.

Oct. 16-18—Briarcliff Manor, N. Y., Semi-Annual Meeting of the American Gear Manufacturers Association, Briarcliff Lodge.

Jan. 5—New York, Convention under the auspices of the National Automobile Dealers Association, Hotel Commodore.

Jan. 26-29—Chicago, Eighth Annual Convention of the National Automobile Dealers Association, Hotel LaSalle.

S. A. E. MEETINGS

September—New York City, S.A.E. Automotive Transportation Meeting.

Oct. 21-24—S. A. E Production Meeting, Detroit.

Nov. 18-19—Joint Service Meeting of the S. A. E. with the N. A. C. C. Cleveland.

Oct. 26—Aeronautical Meeting at Dayton at the time of the Pulitzer Races.

January—S. A. E. Annual Meeting, Detroit.

More Safety Zones Urged by Committee

NEW YORK, June 30—Analysis of the 430 motor fatalities for May reported to the National Automobile Chamber of Commerce by 190 newspapers and other agencies, proving that there has been a decrease, has led the N. A. C. C. Traffic and Planning Committee, of which George M. Graham is chairman, to make the following recommendations:

Safety Education and Play Grounds—Thirty-six per cent of the fatalities reported in May were children. Adequate play grounds must be provided. If necessary, special streets can be reserved as play areas. Education in crossing at cross walks and observance of other traffic conditions should be included in the school courses.

More Safety Zones—Most of the accidents continue to be cases of motor vehicles striking pedestrians. Safety zones give protection to the pedestrian and rob the motorist of any excuse for carelessness.

Analyze the Traffic—Buffalo has studied the flow of traffic along its various streets, knows the time and causes of its accidents and can apply fitting remedies. All cities should approach the subject on this scientific basis.

Activity with the Press—Constant hammering by the press on the causes of accidents, the need for scientific treatment of traffic, and the punishent of offenders serves to create the fundamental necessity of an intelligent opinion.

Impounding the Cars of the Careless—The motorist who disregards the rights of others has no business on the highways. The reckless driver convicted by due process of law should lose the privilege of his car, in addition to other punishments, for a time commensurate with the seriousness of the accident he causes.

The report compiled by Secretary John C. Long shows that the total motor fatalities for the five months of 1924 in which the committee has been compiling these statistics is 1773. May is a bright spot in that 19 cities have a clean record of no fatalities.

Los Angeles made a drop to 10 from its April total of 31. Detroit cut from 34 to 24, Philadelphia from 30 to 21 and Buffalo from 10 to seven. Although Cincinnati's fatalities were twice as large in May as they were in April, this city has registered a decline in fatal accidents for the five months, the record being 38 in 1924 as compared with 52 in the same period the preceding year.

Commenting on the successful record by Detroit and the other cities, the N. A. C. C. points out that these communities have likewise been conspicuous for the efforts of the press, city officials, the schools, safety councils and motor clubs in safety activity.

Detroit, in the face of an enormous increase in motor registrations and discouraging higher traffic fatalities, has been carrying on an unremitting battle which is finally showing some results.

A safety week held in that city May 18-24 brought the subject of traffic control to the direct attention of 782,000 persons. Seven meetings were held in front of the city hall, there were 120 four-minute speakers at the theaters, 37 volunteer speakers in theaters, 15 noon meetings at factories, and other gatherings totaling 539. There was a parade of 93 floats, with 2000 persons marching in line.

This safety week, however, was simply the public demonstration of constant all-round effort on the part of the city toward traffic control.

OLDS DISTRIBUTES CHARTS

DETROIT, July 2—Olds Motor Works is mailing to all its dealers the chart prepared by the National Automobile Chamber of Commerce, outlining the percentage of automobile buying by farmers in the different months of the year. According to the chart, says the company, July, August and September are the largest farm-buying months of the year and it urges its dealers to make special efforts in this market during this period.

Ohio May Make Levy for Insurance Fund

CLEVELAND, June 27—Automobile owners in this city are watching with keen efforts agitation that has been started with a view to creating a State liability insurance fund to take care of persons injured in automobile accidents.

Dealers also are following developments, and wondering what the result of such a move would be on their business.

It is agreed that compulsory liability insurance would cost the automobile owners in Ohio approximately $75,000,000 a year, and that of this amount $15,000,000 to $20,000,000 would be paid by owners in Cleveland.

The argument is heard that the property owner who drives a car is far more careful than he would be if he realized that he would not be called on to pay a claim for damages presented by a person injured by his car, while the non-property owner of a car always has before him the fact that he will be called into expensive litigation and may lose his car on execution to satisfy a judgment if he injured some one while driving carelessly.

The question was first brought up for discussion by Judge Robert S. Marx of the Superior Court of Cincinnati, in an address before the Cincinnati Bar Association. He openly espoused compulsory liability insurance for automobile owners in order to compensate all persons injured in automobile accidents, and he proposed that in order to keep the cost down to the owners the State establish a fund by assessment upon the owners.

REPORTS ON MOON SALES

ST. LOUIS, July 3—F. H. Rengers, general sales manager of the Moon Motor Car Co. of St. Louis, back from an extended trip, declares there is at least 50 per cent fewer Moon cars in hands of dealers than at the same time last year. Business, he says, is spotty.